# UNIVERSITY OF CALIFORNIA COLLEGE OF AGRICULTURE AGRICULTURAL EXPERIMENT STATION BERKELEY, CALIFORNIA

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# PLANT DISEASE AND PEST CONTROL

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# FOREWORD

This circular replaces previous editions of the circular issued under the same number and also Circular 227, by W. T. Horne and E. O. Essig, and Circular 204, by Ralph E. Smith, E. O. Essig, and G. P. Gray, upon which it is based. Professor J. T. Barrett<sup>4</sup> has revised the material on plant disease in this edition.

The plant diseases and pests most common and important in California are briefly treated in the following pages. There are more ample publications on some of the subjects. Two valuable references of special interest in California are:

Essig, E. O. Insects of western North America. 1025 p., 766 figs. The Macmillan Co., New York. 1926. (Includes descriptions, illustrations, and control of all common insects west of the Rocky Mountains.)

Fawcett, Howard S., and H. Atherton Lee. Citrus diseases and their control. xii+582 p., 295 figs. McGraw Hill Book Co., New York. 1926.

A list of the available Experiment Station publications may be obtained by addressing the College of Agriculture, Berkeley, California. Consultations, publications, and other services of the College of Agriculture are free as far as possible.

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# DISEASES AND INSECT PESTS OF CROPS

# **ALFALFA**

**Crown Wart,** Urophlyctis alfalfae (Lag.) Magn.—Crown wart was formerly called crown gall, but is not connected with true crown gall (see p. 78). Rounded irregular tumors develop near the surface of the ground and some plants may be killed. Although widely distributed, it is not often destructive in California.

**Dodder or Love Vine,** Cuscuta sp.—Yellowish threads grow up and entwine the plants, causing serious injury. This is a parasitic plant with minute flowers and with seeds similar in size to alfalfa seeds. Avoid seed in which dodder occurs. The State Department of Agriculture, Sacramento, maintains a laboratory for testing seeds, to which samples may be sent.

Small patches may be killed by mowing and, when dry, burning with other dry material, or kerosene. Afterwards reseed the spot. Badly infested fields should be plowed up. In the drier sections it is reported that dodder may be killed by keeping the field dry for a time, since alfalfa will endure more drought than dodder.

**Downy Mildew**, *Peronospora trifoliorum* De Bary.—Upper leaves become partly yellow with the edges turned down. The lower sides of the leaves have a fuzz which turns violet. It is very common in winter and spring, but not destructive.

Leaf Spot, Pseudopeziza medicaginis (Lib.) Sacc.—Small dark spots appear on the leaves, which fade and drop early if the spots are numerous. Elliptical spots may also appear on the petioles and succulent stems. It is the commonest and most universal trouble of alfalfa in California. Although favored by moist atmosphere, it is worst on weak plants in dry soils under unfavorable growing conditions. It frequently causes loss of nearly all the leaves. Early cutting of heavily infected fields before the leaves begin to fall is recommended.

Rust, *Uromyces striatus* Schr.—Powdery dark-brown dots appear on the leaves. It is not serious in California.

Stem Ret or Wilt, Sclerotinia sclerotiorum (Lib.) Mass. (= S. libertiana Fckl.)—Stem rot is caused by the same fungus as cottony rot of lemons, green rot of apricots and figs, die-back, etc. Vetch

and various leguminous cover crops are attacked. Moist weather favors it. Stems rot off near the surface of the ground and a cottony snow-white mold covers the affected part. Irregular black bodies sometimes larger than sweet-pea seed form in protected places about and in the diseased stems.

Treatment of foliage diseases of alfalfa in California has generally been confined to mowing the diseased stand and applying water if that is needed. Sometimes the ground is disked or treated with a renovator. Early mowing may dispose of a diseased and weedy crop which may be used for silage, or if too bad for this purpose, such a crop makes good orchard mulch. Where the stand becomes too thin or uneven, it should be plowed up and resown. Perhaps no crop is more dependent on proper soil preparation and treatment than alfalfa.

Alfalfa Caterpillar, Eurymus eurytheme (Boisd.).—The caterpillars are about 1 inch long and dark green in color with a distinct line on each side which is often pale yellow or white. They feed on the leaves and may entirely defoliate the plants. The yellow butterflies may be seen in great numbers hovering over the fields. Cutting as soon as the caterpillars appear in destructive numbers, followed by irrigation, is the best method of control.

Armyworms and Cutworms.—See p. 76.

Clover Seed Chalcis, Bruchophagus funebris How.—The small white larva of this insect is just large enough to fill the seed. It occurs in sufficient numbers to greatly reduce the seed crop in most localities in the state. Destroying all the seed heads during winter and the straw after threshing will greatly reduce the infestation for the next year.

Grasshoppers.—See p. 79.

Pea Aphis, Illinoia pisi (Kalt.).—A large green aphis is often abundant on and destructive to alfalfa in many parts of southern California. Spraying and dusting as suggested for this insect under "Pea," p. 52, are usually impractical in alfalfa fields, but may be resorted to under certain conditions. Thorough irrigation following cutting may prove helpful in combating the pest.

Stem Nematode of Alfalfa, Tylenchus dipsaci Kühn.—This nematode is apparently a recent introduction into California. Stems become brown streaked and some branches thickened and distorted, reducing the life and productiveness of the field. Plow up all infected fields and keep the land in a cultivated crop for some years, with special care to completely kill out the alfalfa. See also p. 82.

## ALMOND

Combined Spraying.—Lime-sulfur spraying when the buds are swelling will control shot-hole fungus and peach twig borer, and help to destroy San Jose scale and the eggs of the almond mite. Crude oil emulsions will destroy scale insects, almond-mite eggs, and may arrest some of the fungus diseases when applied as a dormant spray. Summer oils should not be used if trees have been dusted with sulfur or sprayed with sulfur compounds.

Armillaria Root Rot.—See p. 76.

Crown Gall.—See p. 78.

Monilia Blossom and Twig Blight, Sclerotinia cinerea (Bon.) Schroet.—See "Brown Rot" under "Apricot," p. 11. This disease is usually not important in the principal almond-producing districts. The Drake variety has been more severely attacked than other common commercial varieties.

Rust, Tranzschelia punctata (Pers.) Arth. (= Puccinia pruni spinosae Pers.).—Powdery dark brown dots appear on the leaves in summer and autumn. It occurs also on prune, plum, peach, and apricot. No control is known.

**Shot-Hole**, Coryneum beijerinckii Oud.—Shot-hole is due principally to peach-blight fungus. Small spots are killed on the young rapidly expanding leaves, and the living part draws away from the dead area, which drops out. Young fruits are also attacked and may drop. There may be much injury and loss both of fruit and foliage. Spray with lime-sulfur, 1–10, just as the buds are swelling.

Sour Sap.—See p. 83.

Unfruitfulness.—This is usually due to frost or rain at blooming time, or to lack of a suitable mixture of varieties for cross pollination (most varieties are self-sterile), or to the lack of bees for carrying pollen, or to weakness from red spider or other injury the previous year. The selection of suitable soils and thermal-belt situations offer some difficult problems for the almond. See "Frost," p. 79.

Pacific Peach Tree Borer.—See "Peach," p. 54.

Peach Twig Borer.—See "Peach," p. 55.

Red-humped Caterpillar.—See "Plum, Prune," p. 63.

Red Spider or Almond Mite, Bryobia practices Koch.—The largest orchard mite, nearly the size of a pinhead; brownish or greenish with reddish legs, the front pair as long as the body and much longer than

the other legs. The bright-red, globular eggs are laid in great numbers on the limbs and twigs of the trees, where they remain through the winter and hatch in the spring. They also occur on the twigs and leaves throughout the summer and fall. Spray the trees in the winter (January and February) with lime-sulfur, 1–10, or crude-oil emulsion (formula 22) to destroy the eggs. To control the mite during the growing period of the trees apply dry sulfur, sulfur paste, wettable sulfur sprays (formula 35, 36, or 37), lime sulfur 1–50 plus 5 pounds of wettable sulfur, or summer oil sprays, as soon as the mites appear in the spring and as often as necessary during the summer and fall. (See Bul. 347.) Keep plants well irrigated.

San Jose Scale.—See "Apple," p. 9.

# APPLE

Combined Spraying.—(See spray program under "Codling Moth") p. 7.

- 1. For serious infestations of scale insects, for removal of moss or lichens, and for a general clean-up, use lime-sulfur, 1–10, or crude-oil emulsion (formula 22), or lubricating-oil emulsion, during the winter.
- 2. For green, rosy, and woolly aphis, use nicotine and soap (formula 41), distillate emulsion (formula 27), or miscible or summer oils, just as the buds are beginning to open. If only the first two are present and scab is a serious pest, substitute late dormant lime-sulfur, 1–10. This will assist in the control of the San Jose scale, if present. Combinations of oil sprays for insects with lime-sulfur or bordeaux mixture for fungus diseases are often considered advisable, but summer oils should not be used in combinations with, preceding, or following the application of any of the sulfur compounds.
- 3. For codling moth and scab use 2 pounds of powdered, or 4 pounds paste, basic arsenate of lead to 100 gallons of 1-35 lime-sulfur when the petals are falling. For mildew, add 8 pounds of sulfur paste to each 100 gallons of the above and ½ pint of Black Leaf 40 for green or rosy aphis. For later infestations of codling moth and scab, repeat this treatment and also that for mildew and aphis if these need attention.

In large apple-growing districts obtain advice of local horticultural authorities for modifications of the above.

4. For summer infestations of aphis and red spiders, a combined nicotine and sulfur dust may be applied with great advantage.

**Blight**, *Bacillus amylovorus* (Burr.) De T.—See "Pear," p. 57. Remove all worthless apple, pear, and quince trees near apple or pear orchards. Christmas berry, *Cotoneaster*, loquat, and related wild or ornamental plants should be watched for blight.

Mildew, Podosphaera leucotricha (E. & E.) Salm. & S. and P. oxyacanthae (De C.) De B.—A white powdery growth covers expanding leaves and shoots, causing stoppage of growth and distortion. Mature leaves are not much affected. Where mildew is abundant the tree is weakened. It is especially serious in foggy sections. Cut out mildewed twigs as thoroughly as possible in winter. The use of lime-sulfur for the first and later scab spraying may be sufficient for control of moderate mildew infestation (see "Scab"). If the scab sprays are not applied, use sulfur paste, 16 pounds to 200 gallons of water (or home-made wettable sulfur spray, formula 35 or 36) when petals are falling. Later spraying for mildew may be done with the same material. Sulfur sprays cause injury to apple trees in some sections. See also under "Combined Spraying," paragraph 3, p. 5.

The Farm Advisor's office in Sonoma County has given special attention to mildew control and recommends the following program:

(1) Lime-sulfur 1-9, applied in the delayed dormant period. (2) Five to 10 pounds of sulfur to 100 gallons, applied in the late cluster-bud period. (3) Same materials as (2) added to the calyx spray (when the petals have fallen). (4) Same material as (2) added to the follow-up poison spray put on about ten or fourteen days after the calyx period.

No. 2 is considered the most important to prevent the earliest infections, since control after the mildew has become established is difficult.

Sappy Bark, Polystictus versicolor (L.) Fr.—The bark puffs up in winter about wounds, dries out later, and becomes loose and papery. It recurs in succeeding winters, causing death of limbs and general breakdown of trees. Wood decay in the interior of the tree, which is the effect of the growth of the mycelium of the common oyster-shell fungus, is the cause. Avoid large wounds or protect them with a covering of asphalt. See "Wood Decay," p. 86.

Scab, Venturia inaequalis (Cke.) Wint. (= Fusicladium dendriticum Wallr.).— Velvety dark moldy patches occur on young fruit and sometimes on leaves and twigs, and rough corky spots on mature fruit, with distortion. Spray with lime sulfur 1-30, just as winter buds open (early pink stage). Again with lime-sulfur 1-35 when petals are falling. Bordeaux is sometimes used but may russet the fruit; if

used the formula should not be stronger than 3 pounds bluestone and 3 pounds lime to 50 gallons of spray.

Cankerworms.—See p. 77.

Codling Moth, Carpocapsa pomonella (Linn.).—The common white or pinkish worm or caterpillar nearly one inch long is found inside the fruit. For control, spray from two to five times as needed.

The most important problem confronting the apple and pear growers throughout the state is the control of the codling moth in an efficient manner which will at the same time leave very little spray residue at the time of harvest. In order to accomplish this it is advisable to guard against the past tendency to concentrate spraying efforts in the late summer months. Not only has late spraying failed to give the complete control expected and desired, but it has resulted in objectionable amount of spray residue remaining on the fruit when harvested.

More Attention to First Brood of Worms.—There are two fairly distinct broods of codling-moth worms with a partial third brood in the warmer districts. The second-brood worms cause the severe damage to late pears and apples. The second brood is the offspring of the first brood.

The early spray applications are much more effective in codling-moth control and much less objectionable from the standpoint of spray residue than the late applications; therefore, more emphasis must be placed on the calyx and early cover sprays. The first brood must be practically eliminated in order to prevent heavy infestations by later broods.

Arsenate of lead is the only known insecticide that is practical and effective in codling-moth control. Other insecticides, including oils, must be considered either ineffective or still in the experimental stage.

The Calyx Spray.—The calyx spray is the most important spray in codling-moth control. It should be applied when the petals have nearly all fallen. If the application has been unsatisfactory because of windy or rainy weather, or if there is irregularity in the blooming time of different varieties, or if worm control in the past has been especially unsatisfactory, a second calyx spray should be applied before the calyx lobes close. Use an abundance of spray and direct the force of the spray against the blossoms, using spray rods and a tower if necessary.

Use standard (acid) arsenate of lead at the rate of 2 to 3 pounds of powder or 4 to 6 pounds of paste to 100 gallons of water. In the fog belt near the coast, where arsenical injury occurs, basic arsenate of lead should be used at the rate of 3 or 4 pounds to 100 gallons of water.

Cover Sprays for First-Brood Worms.—The first cover spray should be made before any worms begin hatching. If the weather is warm after the trees bloom the first cover spray should be completed by two weeks after the calyx spray, or by three weeks, if the weather should remain cool. Spray thoroughly and apply an abundance of spray for the purpose of completely covering the leaves and bark as well as the fruit.

The second cover spray and subsequent sprays should be applied at intervals of about two weeks when the fruit is growing rapidly.

Late sprays should be made only where infestations are of sufficient importance to warrant further attention. Special advice should be obtained from competent authority before such applications are made.

Banding for First-Brood Worms.—Not all first-brood worms will be killed by the spray. Some will escape regardless of how thoroughly the spraying has been done. A large percentage of these can be captured and destroyed by placing burlap bands around the trunks of the trees about May 20. The bands should be folded to three thicknesses and may be held in place by a small nail. The bands should be examined and the worms destroyed every ten days throughout the summer. This should not be neglected. Rough bark should be scraped from the trunks before banding in order to cause more worms to go under the bands.

Bait Pans.—During the past few years considerable attention has been given to the use of bait pans in connection with the control of the codling moth. The bait consists of a fermented liquid made of 1 part of black molasses and 9 parts of water, to every gallon of which 1 yeast cake is added. After this mixture is allowed to stand 24 hours it is poured into small shallow porcelain pans from 6 to 8 inches in diameter and 2 to 3 inches deep. By means of wires and strings these pans are suspended in the tops of the fruit trees and examined and refilled about once a week. The number of pans used depends upon the immediate conditions of the orchard and may vary from a pan to a tree to one for every two, three, or six trees.

These bait pans serve several purposes: viz., to determine the relative numbers of adults on the wing at a given time; to determine the appearances of the adults for the proper timing of sprays; and as a means of destroying the adults and thus reducing the number of eggs and worms.

Orchard Sanitation.—In addition to the spray program the following control measures are necessary: orchard sanitation such as destruction of windfalls; scraping the bark of rough limbs; thinning of fruit for the purpose of removing infested fruit from the trees, and breaking of clusters so that spraying may be effectively done; proper pruning to facilitate spraying; packing house and dryyard sanitation, such as proper construction and screening of packing sheds, treatment of apple boxes and sacks; destruction of cull fruit and waste products.

Fruit Tree Leaf Roller, Archips argyrospila Walker.—The eggs are laid in small, flat, grayish or brownish masses, usually on the new growth near the tops of the trees, in the fall. They hatch in the spring and the caterpillars draw the leaves together into compact rolls in which they live, and from which they wriggle violently if disturbed. When mature the larvae are nearly 3/4 inch long, deep green, with the head and thoracic shield dark brown or black. The most satisfactory means of control is directed against the eggs, and consists in the use of a miscible oil, lubricating-oil emulsion, or crude-oil spray (formula 22) during the winter. Great care must be taken to thoroughly drench the limbs and particularly the tops and outside branches. Some relief may be had during the summer by spraying with 2 pounds of powdered or 4 pounds of paste basic arsenate of lead to 100 gallons of water.

Green and Rosy Apple Aphis, Aphis pomi DeGeer and Anuraphis roseus Baker.—Both of these aphis are easily distinguished by their color and the characteristic curling of the leaves caused by their method of attack. Control measures are difficult and must be thorough

to secure satisfactory results. Late dormant lime-sulfur, 1–10, applied just before the buds open, gives fair results in killing the eggs, but it is better to spray from the time of the bursting of the buds until the leaf buds are ½ inch long with nicotine and soap (formula 41), or with nicotine and distillate emulsion or miscible oil (formula 28), or to dust thoroughly with 5 or 6 per cent nicotine dust. At this time the young stem-mothers may be destroyed as they hatch from the eggs.

Red-humped Caterpillar.—See "Plum, Prune," p. 63.

San Jose Scale, Aspidiotus perniciosus Comst.; Oyster Shell Scale, Lepidosaphes ulmi (Linn.); and Other Scale Insects.—The scales of the first are circular and gray; while those of the second are oyster-shaped and similar in color. They occur on all parts of the tree, the first causing a red or purplish stain on the bark and fruit. For the San Jose scale alone, spray with lime-sulfur, 1–10, during the winter months. For a mixed infection of scales, spray preferably with crude-oil emulsion (formula 22), with distillate emulsion (formulas 25–27), with miscible oil, or with lubricating-oil emulsions. The lighter oil sprays are not so efficient as the crude-oil emulsions.

Tent Caterpillars.—See p. 84.

Tussock Moths, Hemerocampa vetusta (Boisd.) and Notolophus antiqua (Linn.).—The caterpillars are brilliantly colored and clothed with tufts of white hair on the dorsum, and a single long black tuft at the rear and two in front, the last being responsible for the name 'horn worms.' The eggs appear as white, flat, felty masses on the old cocoons and on the limbs of the trees. They are deposited in late summer and fall, but do not hatch until the following spring. The female moths are wingless, while the males or normally winged.

Control by removing the egg masses during the winter months. Great numbers of the caterpillars may be jarred from the trees and their reascending prevented by applying a band of cotton, wire screen, or tanglefoot around the trunks. Oil sprays applied shortly after the eggs hatch readily kill the young caterpillars. Such sprays are also of value in reducing the codling moth, skinworms, pandemis, cankerworms, bud moth, and other caterpillars. Poison sprays are of little use.

Western Flat-headed Borer, Chrysobothris mali Horn.—The full-grown larvae or borers are white or pale yellow and vary from 15 to 25 mm. (½ to 1 inch) in length. The portion just behind the head is greatly enlarged and flattened, a character which is responsible for the common name. The adult beetles lay eggs on sunburned or other dead areas of the trunk. Whitewash trunks to prevent sunburn and repel

egg-laying. Avoid injuries and wounds. Dig out borers and paint with asphaltum. Apply soap-napthalene repellent (formula 12) early in the spring when leaves start and repeat in 3 to 4 weeks.

Woolly Apple Aphis, Eriosoma lanigera (Hausm.).—This aphis is easily distinguished by the reddish bodies completely covered with white woolly wax. During the winter months spray with distillate emulsion (formula 27), miscible oil, or carbolic acid and distillate emulsion (formula 11). For the root form, expose the crown of the roots and pour in 4 or 5 gallons of any of these spray mixtures and re-cover the roots. Nicotine sulfate (Black Leaf 40) (formula 41) is also effective, or refuse tobacco stems or leaves may be buried in the soil over the main roots during the rainy season. Use paradichlorobenzene during the fall. This material has killed young trees and must be used sparingly. Delicious and Northern Spy rootstocks are somewhat immune and are often used to repel serious attacks of this pest. Of the two stocks, the former is the more vigorous and easily grafted.

# APRICOT

Combined Spraying.—General clean-up may be accomplished by a dormant spray of crude-oil emulsion (formula 22) or miscible oil (p. 5). To control peach twig borer and brown rot, see the program recommended under "Peach Twig Borer," below.

Armillaria Root Rot.—See p. 76.

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Bacterial Gummosis, Bacterium cerasi Griffin.--Gummosis attacks buds, twigs, branches, and trunks, and is recognized by the copious formation of gum. Gum may be found in various other diseases also, and there has been considerable uncertainty as to precisely which of a number of troubles should be counted under this name. The causal bacteria are carried on pruning tools and enter at wounds, being active during cool and wet weather, particularly during late winter and spring. Disinfect pruning wounds and tools (see "Blight" under "Pear," p. 57). In the forms of the disease in which the bark is moist and dead, affected parts should be removed and the wounds treated with bordeaux paste. After winter rains come, orchards should be frequently inspected and cases of gummosis treated promptly. infected spurs on the trunk and main branches should be removed. Treatment in summer or when the disease is not active is of doubtful value, but wounds should be cared for to prevent wood decay (see p. 86). No remedy is known for the bud and twig forms. are being continued on what appear to be two or more different forms

of gummosis, and on more resistant stocks to be used for topworking in order to eliminate the serious body phases of the disease.

Black Heart, Wilt, or Verticilliosis, Verticillium sp.—Certain branches die suddenly in summer, the leaves remaining attached, and the wood of affected twigs becomes dark-streaked far back into the tree. It is caused by a soil fungus which produces wilt in tomatoes and bluestem in raspberries. Where these crops are grown or where certain weeds are permitted the trouble will be worse. Peaches, prunes, and almonds are sometimes affected. Avoid excessive irrigation, severe cutting back, or otherwise promoting too succulent growth. Make conditions as normal as possible. Trees usually outgrow the trouble.

Brown Rot, Monilia Brown Rot, Monilia Blossom Blight, Gumming Twig Blight, or Monilia Rot of Ripe Fruit, Sclerotinia cinerea (Bon.) Schroet.—The brown-rot fungus is active only in moist weather, but may then be very destructive. Flowers are susceptible when the white petals show in the buds and remain so until the 'jackets' (calyxes and other flower parts) are shed from the fruit. The fungus grows down through the flower or fruit, causing it to rot, usually without falling, and penetrates into the spur or twig for several inches. The inner bark and wood turn brown and copious amber gum appears. Long shoots may be killed by girdling from a spur. Ripening fruit is attacked (usually in injuries) and rots, becoming covered with dusty gray powder. If allowed to dry, the rotten fruit becomes a tough mummy, often hanging in the tree over winter. Where fruits are crowded, whole clusters frequently are lost.

The fungus remains alive in mummies and dead twigs and forms spores during wet weather in winter and spring. All stone fruits and almonds are attacked. The Madeline pear is very susceptible. The Japanese quince may be infected in withering flowers and give early sources of infection.

After the crop is off, or at any time during fall or winter, remove all mummies and dead twigs and plow them under, bury deeply, or burn. When the disease is serious, spray with bordeaux 8-8-50 in the red-bud stage (just before the white petals show), or if very bad spray several times up to full bloom. For the fruit rot, bordeaux 4-5-50 may be used up to the time when it will remain and be unsightly on the fruit—perhaps two months before ripening. Limesulfur is efficient in case of brown rot, but has frequently caused 'sulfur sickness' in apricot trees, and is not recommended. Sulfur sickness appears as yellowing of foliage, stunting of fruit, and failure of trees to bloom normally the following year.

Bud Blight, Shot-Hole, Fruit Spot, Peach Blight, Coryneum beijerinckii Oud.—Buds are blackened and killed during winter; spots killed in the opening leaves fall out and leave holes, and small red spots with light centers are formed on the young fruit. Spray with bordeaux between November 15 and December 15, and repeat in spring when the buds are swelling. In districts where spring rains are frequent and spotting of the fruit follows, spray with bordeaux (2–3–50) just as the 'jackets' (calyxes) are shed from the young fruits. The jacket spray may sometimes be used alone with advantage. See "Almond," p. 4, and "Peach," p. 53. This disease is destructive in interior valleys and foothills.

Crown Gall.—See p. 78.

Frost Scabs, Fruit Cracking and Red Specking, Failure of Flower Buds to Open on Strong Shoots, Unfruitfulness of Some Varieties.—These troubles are due to climate or obscure causes, and are often confused with fungus diseases.

Green Rot and Twig Blight, Sclerotinia sclerotiorum (Lib.) Mass.—Twig blight is often associated with brown rot and confused with it. Where the fungus shows on the surface it is snow white instead of gray as in brown rot, and sclerotia may sometimes be found. (See "Stem Rot" under "Alfalfa," p. 2, "Cottony Rot of Citrus," p. 31, etc.) It does not affect the ripening fruit. Effective methods of control are not known, but sprays for brown rot should be of some value.

Rust, Tranzschelia punctata (Pers.) Arth. (=Puccinia pruni spinosae Pers.).—The term 'rust' is applied to this disease because of the rusty spore masses that appear on the leaves and fruit. Small hard points in the skin of the fruit, resembling 'fruit spot' may occur. In a few cases there has been severe dropping of young leaves in early summer and much damage to fruit after heavy spring infection. This early infection comes from fall-infected leaves, which under mild winter conditions remained on the tree. Ceasing summer pruning, which induces young fall growth, has largely prevented the danger of early spring infections. See "Almond," p. 4; "Peach," p. 51; "Plum, Prune," p. 61.

Scab, Cladosporium carpophilum Thuem.—Sooty patches about ½ inch in diameter, and often confluent, form on the fruit, causing drying and eracking. Sprays for brown rot will probably control this, but if not effective, additional sprays after full bloom should be tried, using bordeaux (formula 13, p. 113).

Sour Sap.—See p. 83.

Tumor, Monochaetia rosenwaldia Amram Khazanoff.—Conspicuous, dark, rough enlargements appear on main limbs, especially of old Moorpark apricot trees. The disease is very slow working and for a long time is not noticeably injurious. Finally growth of limbs or whole trees is checked. Cankers on prune, cherry, and some other stone fruits have been associated with this disease but it has not been proved that all of them are due to the same organism.

Wood Decay.—See p. 86.

Branch and Twig Borer, Polycaon confertus Lec.—A small elongated brown beetle, ¼ inch long, which bores clean round holes at the bases of buds, fruit spurs, and in the forks of small twigs. It often makes severe pruning necessary. The insect breeds in dead oaks and other native trees and in prunings of fruit and other trees. Clean up and burn dead brush and prunings around orchards.

Brown Apricot Scale, Lecanium corni Bouché, and Black Scale, Saissetia o'leae (Bern.).—Immature scales of both species are brown or grayish, the latter having a distinct 'H' on the back. They mature in May and June and are nearly hemispherical; the former is smooth and brown and the latter black. Control is directed against the immature winter forms which occur on the new growth. Spray the trees when dormant, December to February, with crude-oil emulsion (formula 22), distillate emulsions (formulas 24–27), or miscible oils, all of which give excellent control for both of these scales. Thoroughness of application is necessary.

Cankerworms.—See p. 77.

Fruit Tree Leaf Roller.—See "Apple," p. 8.

Lesser Shot-Hole Borer, Xyleborus saxeseni (Ratz.) and Bark Beetle, Scolytus rugulosus Ratz.—These are very small beetles boring into the sapwood and heartwood of various fruit trees, preferring usually those not in the best of health. White larvae of the bark beetle may be found during the winter months in sapwood, where they may entirely girdle the trees. Keep the trees growing vigorously; prune out and burn all dead wood; destroy all infested branches immediately.

Pacific Peach Tree Borer.—See "Peach," p. 54.

**Peach Twig Borer**, Anarsia lineatella Zeller.—See "Peach," p. 55, for a description of the insect. The following method of control is recommended by the University of California and the California State Department of Agriculture:

For apricots, where the use of lime-sulfur is likely to cause injury and where a combined insecticide and fungicide is desired to control the peach twig borer and brown rot (first spray), use bordeaux mixture 8-8-50 plus 3 pounds of dry

basic arsenate of lead to every 100 gallons of the spray mixture. Apply this spray at the red-bud stage. Summer sprays with arsenicals should not be applied without consultation with competent authorities.

Red-humped Caterpillar.—See "Plum, Prune," p. 63.

# ARTICHOKE

Artichoke Aphis, Myzus Braggii Gill.—A green and black aphis often occurs in immense numbers on the heads and the undersides of the leaves. Dust with 5 per cent nicotine dust or spray with nicotine sulfate and soap (formula 41).

Artichoke Plume Moth, Platyptilia carduidactyla (Riley).—This moth is 1 inch long, brown, and has narrow wings. The caterpillars are less than 1 inch long and yellowish with black heads. They feed chiefly upon the developing heads of the artichoke, making deep tunnels or eating through the bracts. They are very destructive and their work causes much loss every spring.

Field sanitation is one of the best means of control. Infested heads should be removed at every picking and burned. Burning or deep plowing should be practiced to dispose of the old plants after cutting in May and June. Thistles and escaped or wild artichoke plants should be promptly destroyed to eliminate breeding places. Dusting with 5 per cent nicotine dust or with a combination of arsenate of lead and 5 per cent nicotine dust, in the proportion of 1 pound of powdered arsenate of lead to every 4 pounds of the nicotine dust, is recommended after each picking, until the attacks are reduced to a minimum.

### **ASPARAGUS**

Rust, Puccinia asparagi D. C.—Minute yellowish blisters or sori appear on leaves and stems; these rupture and become rust-colored and dusty and later black. Plants become pale and bare and are much weakened for succeeding crops. Keep down all volunteer growth of asparagus in and about the fields. Burn all old growth after it dies and cultivate all surfaces well before new growth comes up. After cutting stops, irrigate and cultivate to secure vigorous growth, and in about three weeks dust with sulfur while the dew is on, or spray with resin-bordeaux (formula 15) or lime-sulfur containing fish-oil soap for a spreader, or with fish-oil soap followed by dusting with sulfur while still wet. Repeat once or twice, according to the severity of the disease in the vicinity. For young fields, dust repeatedly with sulfur as above to prevent infection, beginning when the tops first fully feathered out. Resistant varieties are available.

Asparagus Beetle, Crioceris asparagi Linn.— The beetles are slender, ¼ inch long, metallic blue-black with red and yellow markings. The larvae are dull brown or olive green with black head and legs. They feed in great numbers upon the seedlings. Control by clean culture, by cutting and burning seedlings, or by spraying them with nicotine soap spray (formula 28 or 41). A 6 per cent nicotine dust or 25 per cent calcium-cyanide dust also gives very efficient control.

Garden Centipede, Scutigerella immaculata (Newport).—These are small, white, centipede-like animals, scarcely more than ¼ inch long. They live in the damp soil in great numbers and often seriously damage the young asparagus tips before they reach the surface of the soil. Clean culture, winter flooding, and crop rotation are the best control measures.

# **ASTER** (Callistephus chinensis (Nees.)

Aster Yellows.—Young leaves with transparent venation (see "Virus Diseases," p. 63), erect, plant becoming irregularly chlorotic (yellow), stunted, with abnormal branches, flowers with part or all petals green. The disease is spread by a gray leafhopper, about 1/8 inch long, Cicadula sexnotata Fall. It is not carried over in the seed or eggs but in some diseased perennial plants. Numerous garden plants and weeds are affected. In lettuce it is the white-heart disease. It was formerly rare in California though common in the East. No control is known. Herbaceous plants brought from the East should be watched and suspicious ones destroyed. Also any herbaceous perennials which appear abnormal might be destroyed. Other plants in California known to be subject to natural infection are: celery, California poppy, African marigold, Hamburg parsley, Short White carrots, White Belgian carrots, and zinnia.

Wilt, Stem Rot, Fusarium sp.—Plants begin to wilt and die when the leaves have attained full size and continue to the end of the season. Stems are rotted off above the surface of the ground and below. The disease is difficult to control but growing the seedlings in sterilized soil should help. Avoid excessive watering.

### AVOCADO

Blast, Citrus Blast, Bacterium citriputeale C. O. Smith.—It has been shown that the citrus-blast bacterium may attack the avocado. The disease is believed to be local and it may sometimes have been confused with end spots and fruit blemishes. See "Citrus Blast," p. 30.

Canker Diseases.—Canker diseases are rather uncommon and have not been fully studied. Large, striking, and serious sores may appear on mature trunks. At least part of these cankers are due to the same fungi which cause gum disease in citrus trees. In the avocado exuding gum soon changes to a whitish granular mass. See "Gummosis," under "Citrus," p. 32.

End Spots.—Where fruits remain on the tree after maturity, large areas at the side or blossom end shrivel and turn hard and dark. Often the skin or shell cracks and sometimes loosens from the flesh. Flesh below the surface is not much affected except in severe cases, when it may darken. Where the hard surface cracks decay organisms may enter. These spots appear to be caused by desiccation during summer or winter. Sometimes end spots may develop before the fruit is fully mature.

Fruit Blemishes.—Mature fruits are sometimes marked by large corky scabs covering much of the surface. Deep cracks give opportunity for some decay organisms to develop. At least part of these scars originate when the fruit is very small, even when less than ½ inch long. Contact of the tender young fruit with a leaf edge or petiole may cause a surface injury which soon turns dark and later cracks and forms a hard surface blemish. Shelters against wind and the early removal of scarred fruit seem the only measures available.

Fruit Spoilage.—Fruit of the avocado must be used soft and is perishable when ripe. It does not soften on the tree but ripens rather quickly after picking, even though still so immature as to be thin in flavor. When overripe it becomes very soft and more or less darkened in flesh and fibre and the flavor changes somewhat.

The firm fruit on the tree except where cracked or injured is very little subject to decay in California, but the ripe fruit, especially in injuries, is very subject to invasion by many molds and bacteria. The most destructive decay of ripe fruit in California is caused by common black mold, or bread mold, *Rhizopus nigricans*. The rot spreads rapidly, causing the flesh to become very soft, watery, and offensive in odor. A coarse cottony mold may appear in injuries or on the surface. It is at first white, but soon becomes covered with black points. Many molds grow slowly so that the affected spot may be trimmed off and the fruit used. The blue and green molds of citrus fruits are not of importance on the avocado, but related forms, such as apple green mold, cause the slow types of decay. Putrefactive bacteria enter in late stages of overripeness or spoilage and cause offensive rot. Low temperature retards the ripening process and also the growth of most

of the molds which cause spoilage. The calyx or stem scar is the most vulnerable point for entrance of decay organisms; it may be disinfected and waxed if desired.

Little-Leaf and Chlorosis.—This trouble has not been extensively studied for avocado. See p. 76.

Sun Blotch.—Sun blotch is supposed to result from sunburn. Young twigs grow out with yellow grooves or streaks. Some varieties have variegated and deformed leaves, green fruits have yellow depressions, while dark fruits have large red areas. Avoid affected trees in choosing scions.

**Sunburn.**—Fruits, young leaves, stems, and trunks are liable to injury if freely exposed to very hot sun and wind. Sunburned leaves show spots of dead tissue of various sizes; often partly grown leaves have large spots killed and these later drop out, giving a ragged and imperfect outline. Other parts are either paler than normal or the tissue is killed and blackened. Exposed limbs should be whitewashed and the moisture supply kept up during hot spells. See "Sun Blotch," p. 17.

Tip-Burn.—Leaves dry up gradually from tips and outer edges. Trees may suffer from loss of green leaf area. Tip-burn is due to accumulation of salts (common salt or white alkali) in the leaves. Much wind, excess of salts in the soil or irrigation water, or lack of nitrogen in the soil make the trouble severe. Avocados will endure somewhat less of salts, especially common salt, than citrus trees. Where not too severe it may be ameliorated by developing shelter, by securing better water or making a better use of the same supply, and by generous use of proper nitrogen-bearing fertilizers.

Unfruitfulness.—Many large seedling trees do not blossom. Other trees blossom but set no fruit; still others set fruit, but it falls before maturity. Girdling large limbs or whole trees may greatly increase any tendency to fruitfulness. Girdling is of value only in vigorous limbs or trees. Avocado flowers are perfect, but have an unusual blossoming behavior (see Ext. Cir. 43, p. 47). Pollination may be defective. Shedding of the fruit already set (abscission) is due to many causes and may be very hard to prevent.

Water Injury.—Certain tree failures are evidently due to excess water in the soil. Hardpan or other defects in soil structure may be responsible. The trees are sensitive to excess water in the soil and have poor recuperative power after such injury.

Bark Beetle.—See "Lesser Shot-Hole Borer" under "Apricot," p. 13.

Branch and Twig Borer.—See "Apricot," p. 13. Sap collecting in the burrows produces, on evaporation, white powdery masses over the entrances, completely concealing them.

Spanish Red Scale, Chrysomphalus dictyospermi Morgan.—A pale brown, circular scale, infests all parts of the tree and is serious in greenhouses, and also in orchards in California. Control by using summer or white oil sprays.

Thrips: Bean Thrips, Heliothrips fasciatus Perg., and Greenhouse Thrips, H. haemorrhoidalis Bouché.—See "Prune," p. 62. These insects attack the leaves and fruit, causing a shiny, hard, discolored surface which has a tendency to check or crack, and which is covered with numerous fine specks of excrement. They are controlled same as pear thrips (see p. 60) or by the use of dusting sulfurs.

BARLEY—See "Grain," p. 40

### BEAN

Anthracnose, Colletotrichum lindemuthianum (S. & M.) B. & C.—Spots on leaves, stems, and pods, up to 0.4 inches in diameter, dark-colored, usually with a red border and pinkish in the center. Very rare and unimportant in California.

Mildew, Erysiphe polygoni D. C.—Mildew forms a powdery white covering over green parts of the plants, which later turns brownish. It may seriously reduce the vitality of the plants. Dust with sulfur at first appearance, or with sulfur nicotine dust if thrips or aphis are present. Mildew sometimes appears late when the pods are well formed. The Hopi lima is resistant. No treatment is necessary in this case.

Rust, Uromyces appendiculatus (Pers.) Link.—Rust-colored spore masses or sori of pinhead size break through the lower surface of the leaf, with yellow spots above. Affected leaves are weakened and production decreases. Dust with sulfur at first sign of the disease and keep the surface of the soil dry by cultivation. Resistant varieties have been reported.

Wilt or Stem Rot, Corticium vagum B. & C. (= Rhizoctonia, and Fusarium sp.).—Many plants die while small from rot near the surface of the soil, and others wilt at different stages. Prepare the soil very thoroughly and plant as late as possible, avoiding cold and wet weather. Save seed from strong, well-matured plants.

Bean Aphis, Aphis rumicis Linn.—A small black louse collects in great numbers on the leaves and tender tips. Use 5 per cent nicotine dust or spray with nicotine paste spray (formula 42).

Bean Pod Borer, Etiella zinckenella (Treit.).—The larvae or caterpillars of this small gray moth burrow through the green pods of husk lima beans and feed upon the developing beans inside. No practical artificial control is now available. Some strains of the Hopi lima show resistance to its attacks

Bean Thrips, *Heliothrips fasciatus* Perg.—This small dark thrips has black and white wings. The larvae are white and pinkish and appear in great numbers on the lower surface of the leaves. Treatment the same as for bean aphis.

Bean Weevil, Mylabris obtectus (Say).—The adults are short, robust, and about ½ inch long. The color varies from gray to brown with pale spots on the dorsum. The larvae work within the stored beans, from which the adults emerge through round holes. Breeding continues in storage. Fumigate in storage with carbon disulfide, 10–30 pounds to every 1,000 cubic feet of air space, the amount depending upon the tightness of the container. The temperature should be above 70° Fahr. to secure satisfactory control by killing eggs, larvae, and adults.

Garden Nematode.—See p. 82. Black eyes and teparies are more resistant than other beans, but are sometimes badly infested.

Red Spider, Tetranychus telarius Linn., Pacific Mite, T. pacificus McG., and Two-spotted Mite, T. bimaculatus Harvey.—These are very small, yellow, pale-green or reddish mites, the third with two large dark spots on the body. They feed on the under sides of leaves and often spin a considerable web. If possible keep the beans well irrigated and cultivated and in good healthy condition. Begin sulfuring as soon as the mites appear and continue throughout the summer, using 90 parts of dry sulfur to 10 parts of finely ground dry hydrated lime.

Wireworms.—See p. 85.

### BEET

Curly top, Curly leaf, or Blight.—Curly top is transmitted by the beet leaf hopper, *Eutettix tenellus* (Baker). Leaf margins curl inward or rarely outward and are much dwarfed and deformed; plants are stunted and easily killed by drought and heat; young leaves show transparent venation (a clearing of the ultimate leaf vein branches), and a warty condition usually develops on the backs of veins on old leaves.

Roots often become hairy and show dark rings in cross section. In the cool districts subject to ocean fogs, the insects do not reproduce abundantly and the disease when established is less injurious. Beets in all other parts of the Pacific slope and of the Rocky Mountains are liable to injury, but in certain regions have been observed to suffer less than in others. Early planting (December to March 1 in interior regions) to bring the beet to a good size before the spring invasion of the insects from plains and foothills is generally successful except in years following early fall rains, which bring up filaree and other vegetation and cause a large number of insects to winter in the cultivated area. In the fog belt and coast valleys of central California early planting, then cessation, then resumption of planting in May and June is recommended (see Exp. Sta. Circ. 302 and Bul. 465). Blighted stecklings do not produce seed successfully, although the symptoms may not always be apparent.

It has been shown that beans, beets (all varieties), spinach, Swiss chard, tomatoes, potatoes, peppers, cucumbers, squashes, varieties of melons, other garden plants, and many weeds, become stunted and unproductive from this disease in districts and seasons when it is severe (see Hilgardia, Vol. 3, Nos. 13 and 20). The specific symptoms described for beets are not always developed and the nature of the disease can be determined only by expert laboratory tests involving use of the leafhooper.

Downy Mildew, Peronospora schachtii Fckl.—Inner leaves become curled, dwarfed, and covered below with a violet mildew. It develops in moist weather. Heavily attacked plants are stunted and spoiled but with bright weather some are said to recover. Removal of badly affected plant is recommended but rarely practiced.

Leaf Spot, Cercospora beticola Sacc.—Leaves have dead gray spots, mostly ½6 inch in diameter or smaller with borders of brown or purple. Treatment is not considered necessary.

Rust, Uromyces betae (Pers.) Kühn.—Powdery dark brown pustles of pinhead size appear on the green leaves; it is not serious.

**Seedling Root Rot**, Corticium vagum (B. & C.) (=Rhizoctonia and Fusarium sp.).—Roots are injured and become misshapen and forked; plants are delayed or stunted or die. Make the soil conditions as favorable as possible for vigorous growth. Replant if the stand is too thin.

Armyworms and Cutworms.—See p. 76.

Beet or Spinach Leaf-Miner.—See "Spinach," p. 68.

Grasshoppers.—See p. 79.

Nematodes.—See p. 81. The beet is attacked by two species, the garden nematode, *Caconema radicicola* (Cobb), which produces galls on a number of plants, and the beet nematode, *Heterodera schachtii* Schmidt, which is confined mainly to beets and does not produce galls.

Sugar Beet Leafhopper, Eutettix tenellus (Baker).—This insect, referred to under "Curly Top," is wingless in the immature form and winged when full grown. The adults average about ¼ inch in length. The color varies with the season, those of the spring brood being pale green, those of the summer brood cream-colored, and the winter generations dark-colored with darker markings on the wing covers. The insects are to be found chiefly on the under surfaces of the leaves or between the stems near the crown, thus introducing the virus which causes the characteristic curly top.

Wireworms.—See p. 85. For the sugar-beet wireworm, *Limonius californicus* (Mann.), plow in fall to destroy the pupae. Plant early and practice clean culture. Trap the adults by means of piles of straw and burn in late fall or winter.

# BULBS (Daffodil, Freesia, Gladiolus, Narcissus, Tulip)

Freesia Red Bulb Disease.—Plants blacken and often rot near the surface of the ground, bulbs become dark stained. This is not a simple malady, as was formerly supposed. Avoid frosty situations and poorly drained soil. Plant white bulbs, use new land, give the best possible care. Progress has been made in the study of this disease. but control is not yet fully developed.

Gladiolus Scab or Stem Rot, Bacterium marginatum McC.—Definite circular spots with characteristic darkened margins appear on the lower part of the leaves and on the corms. Destroy all severely affected corms. Wet the remainder several hours in water, and then treat one-half hour in a 1–1,000 solution of mercuric chloride or a 1–100 solution of formaldehyde. Do not plant in infected soil.

Narcissus and Amaryllis Leaf Spot, Phyllosticta narcissi Aderh.—Pale dead areas occur on narcissus, daffodils, and related plants. Yellow and finally dead streaks develop above and below these, causing early withering of leaf or stalk and consequent reduction of foliage. Apparently the same fungus on Amaryllis (Hippeastrum) spp. causes bright red spots, which in brighter, warmer sections are important largely as blemishes of show blooms. Crowding, shading, low temperature, soggy soil, and excessive moisture are probably contributing factors. A suitable spray treatment has not been developed, but bordeaux with a spreader (see formulas 13 and 15, and pp. 113–114), should be tried for early sprays, and formula 18 for application when a foliage stain would be objectionable.

Tulip Fire Disease, Botrytis tulipae (Lib.) E. F. Hopkins.—This disease is characterized by minute yellowish spots on the leaves. By

coalescing, larger spots may result. Disfigurement of the flowers is common and is particularly apparent on the red varieties. Removal of trash which harbors the fungus is recommended.

Bulb Fly, Merodon equestris (Fabr.), and the Lesser Bulb Flies, Eumerus strigatus (Fallén), E. tuberculatus Rond., and E. narcissi Smith.—Large and small flies produce large and small, whitish or brownish maggots inside the bulbs of narcissus, amaryllis, hyacinth, eurycles, galtonia, habranthus, hippeastrum, Spanish iris, lilies, tulips, vallota, onions, and shallots. The control is by treating in hot water for two hours at 110° Fahr. or fumigating with HCN after digging or before planting.

Bulb Mite, Rhizoglyphus hyacinthi Boisd.—This is a whitish or yellowish, slow-moving mite often with brownish spots on the body. It is most abundant on rotting bulbs, tubers, rhizomes, roots, and decaying vegetable matter generally, and is responsible for carrying fungus disease, causing rot, from infected to clean bulbs in the soil and in storage. Only clean bulbs should be planted. After digging and curing, dip the bulbs in a 2 to 4 per cent commercial lime-sulfur solution, preferably heated in a large kettle to 125° Fahr. for not over one minute. Dry and then place in dry, well-ventilated storage. Small lots of bulbs may be effectively treated with a liberal amount of 5 per cent sulfur-nicotine dust in paper-bag containers which may be securely tied and the dust allowed to remain until ready to plant. This will also kill mealy-bugs and aphis.

Narcissus Stem Nematode or Bulb Nematode, Tylenchus dipsaci Kühn.—Raised, blister-like areas appear on the surface of the leaves, and badly diseased plants are lighter colored and greatly reduced in vigor. The cut bulbs show discolored streaks and rings. Gradually enlarging areas of infestation develop in plantings left year after year without digging. Many imported bulbs are somewhat infected and new areas of infestation are being discovered from time to time. A hot-water treatment, in which bulbs are immersed for 3 hours in water kept at a temperature of 110°-111.5° Fahr. is recommended. possible that higher temperatures may be used with advantage. Diseased plants should be destroyed as soon as detected. The remaining bulbs in an infested field should not be sent to market. It is probable that the apparently sound bulbs from infested fields may be treated and grown in clean land and a clean crop produced. Infested land should not be used for bulbs for several years. This is a new problem in California and is still under investigation.

# BUSH FRUITS (Blackberry, Loganberry, Raspberry)

Bluestem, Verticillium sp.—Blackcaps and the variety Ranare are said to be particularly susceptible. Plants become sickly and canes die back. The disease is caused by the same soil fungus as black heart of apricots and wilt of tomatoes, potatoes, and many other plants. Methods of control are not known. Select plants from healthy fields. Avoid planting raspberries after tomatoes or potatoes.

Cane Blight, Leptosphaeria coniothyrium (Fckl.) Sacc. (= Coniothyrium fuckelii Sacc.).—Dead areas of brown color appear on the canes, which are often girdled and killed. Cut out and burn all affected parts in the fall. If severe, spray with bordeaux during the dormant season.

If foliage and cane diseases are serious, there will probably be an advantage in removing the fruiting canes immediately after the crop is off, or at least before any moist autumn weather. Spray during the dormant season with lime-sulfur 1–10 or bordeaux (formula 13). Give proper irrigation and cultivation. If fields become unhealthy, reset in new land, using healthy plants.

Crown Gall, Bacterium tumefaciens Sm. & T.—See p. 78.

Fruit Mold, Botrytis and other fungi.—See "Strawberry Fruit Mold," p. 69.

**Leaf Spot**, *Mycosphaerella rubi* (West.) Roark (= *Septoria* sp.).— Small dead spots occur on leaves and canes, with brown or reddish borders. The disease is liable to be severe on Mammoth, Cory, wild dewberry, and loganberry. Treat as for cane blight above.

Orange Rust, Gymnoconia interstitialis (Schl.) Lagerh.—Individual plants are affected and ruined. New shoots come up pale, dwarfed, and with the leaves curved inward and drawn upward. Orange-colored spores cover the surface of the leaves. It seldom if ever occurs on red raspberries. Dig out and burn affected plants at the first appearance of the disease. Spray healthy plants in the vicinity with bordeaux mixture to prevent infection.

**Powdery Mildew**, Sphaerotheca humuli (D. C.) Burr.—White mycelium spreads over the young leaves, canes, flowers, and fruits, producing a stunted growth. Fruit attacked in an early stage seldom matures. The first mildew in the spring appear on new shoots 6 to 12 inches high. The fungus survives the winter by means of perithecia on refuse and only occasionally as mycelium within buds.

Removal and destruction of cane tips in winter as commonly practiced with the variety Ranere eliminates a large amount of the over-

wintering fungus. Disposal of as much of the refuse around the base of the canes as possible would also be beneficial. Spraying experiments are lacking, but satisfactory control has been obtained by growers using a single application of dormant-strength (1–10) lime-sulfur during December or January. This spray should be directed especially at the refuse on the ground.

Raspberry Leaf Rust, Phragmidium imitans Arth.—Small light-yellow pustules appear on young leaves and black spores form later. On the variety Ranere the attack is usually confined to the older leaves later in the season, and is doubtless injurious but not destructive on this variety. On Cuthberts the rust may be very severe, attacking all leaves and occasionally forming pustules on the canes.

Methods of control have not been fully developed but thorough clean-up and disposal of old foliage in the winter is advisable. A dormant spray of lime-sulfur 1–10 as used for powdery mildew should be beneficial.

**Spur Blight,** Mycosphaerella rubina (Pk.) Jacz.—Early in the season the tissue surrounding the bud at the base of the leaves turns brown, the bud stops development and becomes shriveled. Discolored areas spread so that the entire lower part of the cane may become dark purplish-brown. Affected canes bear fruit only near their tips.

For control Sackett of Colorado recommends the use of bordeaux 3-2-50 plus 2 pounds of resin fish-oil soap. Make the first application when young canes are 8 to 12 inches high, and the second two weeks later. Apply only on young canes for protection.

Blackberry Mite, Eriophyes gracilis (Nalepa).—This is a small microscopic mite causing the redberry condition of the Himalaya, Mammoth, and other blackberries and loganberries throughout the state. The mites attack the drupelets of the berries shortly after the flowers open and continue to work in the fruit, preventing ripening. The winter is spent in the buds, and the pest can be effectually controlled by spraying the infested vines in February or March, as the leaf buds are opening, with lime-sulfur solution, 4–8 gallons to 100 gallons of water.

Summer control may be obtained by spraying with summer oil or white oil sprays.

Raspberry Horntail, Hartigia cressoni (Kirby).—The small white larvae are shaped somewhat like the letter "S" and when mature are nearly 1 inch long. They first attack the tender tips of the new canes and after girdling them and causing wilting they work down the pith to the roots, where they spend the winter. Cut off the young tips as

soon as wilting is noticed so as to kill the larvae before they reach the roots. Remove all dead canes in winter, using care to dig out the borers at that time.

Rose Scale, Aulacaspis rosae (Bouché).—This is a pure-white scale often found in great numbers at the bases of the old canes. Spray in winter with distillate emulsion (formula 27) or with miscible oil. Prune out old canes every year, because infestation spreads from them. It is serious only where pruning is not practiced every year. Lime-sulfur used as a fungicide gives some control.

Tree Cricket, Oecanthus niveus DeGeer.—A pale-green or yellowish cricket feeds on the buds, blossoms, and young fruit of the raspberry, often doing great damage to the second crop. For control make a single application of a dust containing 70 per cent sodium fluosilicate and 30 per cent diatomaceous earth, applied at the rate of 50 pounds to the acre. Perfect control results in 14 days. This dust is recommended for application between the first and second crops, at which time there are few or no berries on the bushes. Picking of berries from dusted bushes is forbidden, because of the poisonous effects of the dust, for a period of ten days to two weeks. During this time the berries on the bushes at the time of dusting ripen and drop off, leaving clean berries to follow later.

# CABBAGE

Yellows, Wilt, Fusarium conglutinans Woll.—Plants gradually turn yellow and the lower leaves fall. Stem shows a dark ring when cut across. Loss may be severe. It is reported as especially trouble-some on kale. Grow plants in soil free from disease (see "Soil Disinfection," p. 126). Avoid infected land. Certain strains of cabbage are resistant.

Armyworms and Cutworms.—See p. 76. Scatter poison bran (formula 5) broadcast over the ground and plants in the evening.

Cabbage Aphis, Brevicoryne brassicae (Linn.).—A small green aphis entirely covered with fine whitish powdery wax. Is best controlled by liberal and repeated applications of nicotine-distillate spray (formula 28) or of nicotine soap (formula 41). Nicotine dust gives only partial control.

Cabbage Maggott, Phorbia brassicae Bouché.—The small white maggots, ¼ inch long, are found tunneling the roots, which are often completely destroyed by them. The insect also attacks radishes, turnips, cauliflower, and other related plants. The most effective

means of control is in the use of a repellent composed of 1 ounce of mercuric chloride to 10 gallons of water. Three applications should be made, using one cupful (½ pint) around the base of each plant, as follows: first application 3 or 4 days after transplanting; second application 9 or 10 days after transplanting; third application 19 to 20 days after transplanting. Later applications should not be made on account of the danger of poisoning. The material may be applied with a watering can suitably regulated. Clean up all refuse in the fall and plow and cultivate thoroughly during fall, winter, and spring, before transplating, to expose and kill over-wintering pupae in the soil.

Cabbage Worm, Pieris rapae Linn.—A small green velvety worm, 1 inch long when mature, feeds upon the leaves and destroys the heads. The adults are white butterflies with dark spots on the front wings. Young cabbage plants may be protected by using arsenate of lead, 1 pound of powder or 2 pounds of paste, to 50 gallons of water. This should not be applied after the heads are formed because of possible poisoning of humans. Later control may be accomplished by applying a nicotine-soap spray (formula 41). A 5 per cent nicotine dust also gives very good control when liberally applied.

# CAMELLIA

Bud Blight.—Browning of the tips of the buds, followed by decay and dropping, is due frequently to injury from thrips. This should not be confused with the dropping of the buds caused by lack of irrigation.

CANTALOUPE—See "Melons," p. 47

# CARNATION

Rust, Uromyces caryophyllinus (Sch.) Wint.—Prominent pustules or sori appear on leaves and rupture, exposing the dark brown spores. Control by growing resistant varieties or in greenhouse culture by keeping the surface of the plants and soil as dry as possible.

Stem Rot or Wilt, Fusarium sp.—The stems rot off, usually near the surface of the ground, and the plants wilt and die. Remove affected plants promptly and burn. Select cuttings from the healthiest plants, use clean sand for cutting beds, and non-infected soil for growing the plants. If the trouble is serious, soil sterilization—especially for the cutting beds—is promising in this connection (see p. 2).

CASABA—See "Melons," p. 47

# **CAULIFLOWER**—(Also see "Cabbage," p. 25)

Alternaria Leaf Spot and Brown Rot, Alternaria brassicae (Berk.) Sacc.—Small dark-brown or grayish spots occur on leaves and reach ½ inch in diameter. On the leaf mibrids the spots are small and elongated. Minute black areas appear in the centers of the spots and consist of the spores of the causal fungus. Badly affected leaves turn pale and drop. The surface of the heads (curds) at first show minute brown specks, later the head becomes dark and greenish. Cabbage and related plants are attacked. Seed should be disinfected (see (Rhizoctonia,'' under "Potato,'' p. 64). Make the seedbed from soil not contaminated with remains of cauliflower or related plants; if the disease appears in the seed bed, remove the affected plants promptly and spray with bordeaux mixture (formula 13); use the same spray in the field if the disease is present; ship only perfectly sound heads and keep the temperature of the car down as near as 40° Fahr. as possible; in the market keep the heads cool and dry.

Ring-Spot, Mycosphaerella brassicicola (Fr.) Lind.—Ring-spot causes brown dead areas from very small to nearly ½ inch in diameter. A persistent green ring surrounds the spot. Minute black fruiting bodies develop in the dead areas, sometimes arranged in rings. It has caused serious losses in some years. Control has not been developed but measures suggested under leaf spot should be tried.

### CELERY

Blight, Cercospora apii Fr. and Septoria petroselini Desm.—Large or small dead spots appear on the leaves and leaf stalks, especially after cutting, and rapid deterioration follows. Spray repeatedly with bordeaux (formula 13), especially in moist weather, commencing in the seed bed.

**Aphis**, *Myzus persicae* (Sulz.) and *Cavariella capreae* (Fab.)—Green aphids attack the stems and leaves of the plants. Spray with nicotine soap (formula 41) or dust with 5 per cent nicotine dust.

**Celery Caterpillar,** Papilio zolicaon Boisd.—The caterpillars are beautifully marked, green black and orange, and feed upon the leaves. Hand pick, or spray with 3 pounds of powdered arsenate of lead not later than three weeks before harvest (formula 2).

Celery Leaf-tier, *Phlyctaenia ferrugalis* Hbn.—The caterpillars are pale green with white or yellow stripes and the adults pale fawn. The larvae web and devour the foliage and are frequently serious pests. Control is the same as for the celery caterpillar.

# CHERRY

Armillaria Root Rot.—See p. 76.

Gummosis, Die-back.—See p. 79. Several distinct troubles are involved, and frequently diagnosis is difficult. On certain shallow soils it is reported that cherries die after a few years with copious gumming throughout the top. For bacterial gummosis it is recommended to grow Mazzard seedlings in the orchard and top work after several years with the desired varieties above the main forks (see "Apricot," p. 10). Cherries are sensitive to excess of water in the soil and to summer drought and do not recover well from injury through soil defects.

Leaf and Fruit Spot.—See "Bud Blight," under "Apricot," p. 12; "Peach Blight," under "Peach," p. 53, and "Shot-Hole," under "Almond," p. 4.

**Leaf Curl**, *Exoascus cerasi* Fuckel.—Leaves are affected in a way similar to those of peaches with peach leaf curl, but the symptoms are less pronounced (see "Peach," p. 53). The treatment for peach leaf curl has been reported by practical orchardists to be successful with the cherry. Leaf curl is rather rare on the cherry.

Leaf Spot, Coccomyces hiemalis Hig. (= Cylindrosporium padi Karst.)—Tiny spots covering most of the leaf surface and fusing at the lower edge. The under side shows whitish coating of spores. It is not serious as yet. Controlled in the East by bordeaux mixture, 5–5–50, or lime-sulfur 1–50, with iron sulfate 1½ pounds added, or dusting with sulfur. Applications as follows: (1) when the fruit is free from the calyx, (2) two weeks later, (3) just after the fruit is picked.

**Sour Sap.**—See p. 83.

Wood Decay.—See p. 86.

Black Cherry Aphis, Myzus cerasi Fabr.—A shiny black aphis with long honey tubes, appearing in spring and early summer and causing severe curling of the leaves. Spray with nicotine and soap (formula 41) or dust thoroughly with 5 per cent nicotine dust as soon as aphis appear and before the leaves curl.

Cankerworms.—See p. 77.

Cherry Fruit Sawfly, Hoplocampa cookei (Clarke).—The small white larvae work within the partly developed fruits of the cherry and plum and are at times responsible for much damage. Their presence is indicated by the dropping of fruit and by the small round

exit holes in fruits which are hardly half-grown. The best treatment is the application of arsenate of lead (formula 2) just when the petals are opening.

Cherry Slug, Eriocampoides limacina Retzius.—This name applies to the small dark green or blackish slug-like larvae which are nearly ½ inch long and which feed upon the leaves in great numbers, almost defoliating the trees in some years. Because of their slimy covering they are readily killed by the application of various dusts, such as finely ground hydrated lime, ashes, road dusts, etc., but are best controlled by the applications of 2 per cent or 5 per cent of nicotine dust. The regular arsenate-of-lead sprays (formula 2) are also good.

Pacific Peach Tree Borer.—See "Peach," p. 54.

Pear Thrips.—See "Pear," p. 60.

Red-humped Caterpillar.—See "Plum, Prune," p. 63.

Tent Caterpillars.—See p. 84.

# CHRYSANTHEMUM

Rust, *Puccinia chrysanthemi* Roze.—Small dark pustules or sori appear on the lower side of leaves. Fertilize and irrigate freely to produce vigorous plants.

Aphis (Various Species).—Spray with nicotine and soap (formula 41) or dust with 5 per cent nicotine dust when the insects appear.

Chrysanthemum Gall Fly, Diarthronomyia hypogaea (Löw).— The small yellowish or white larvae cause numerous pointed galls on the leaves and stems and seriously injure the terminal buds. Great numbers of minute slender red eggs are laid on the plants in the spring and early summer, and these may be readily killed by repeated applications of nicotine and soap (formula 41). Trim the plants to the ground in the spring to eliminate hold-over forms.

Chrysanthemum Leaf Miner, *Phytomyza chrysanthemi* Kow.— The injury due to this insect consists in numerous mines on the upper side of the leaves just under the epidermis. These are made by the small whitish maggots, which are easily killed within their burrows by applying one part of 40 per cent nicotine sulfate to 600 parts of water.

### CINERARIA

Leaf Miner.—The injury is similar to that of the chrysanthemum leaf miner and caused by the same insect.

# CITRUS FRUITS (Grapefruit, Lemon, Orange)6

Armillaria Root Rot.—See p. 76.

Blast, Black Pit, Bacterium citriputeale C. O. Smith.—Blast occurs only in very moist seasons and districts; black pit occurs with blast and also, rarely, in less moist localities. Blast is a watery deterioration of leaves and petioles extending to a shield-shaped area in the twig about the base of the leaf. Leaves die and dry up in place, the twig lesions turn dark, dry up, and heal, and shed off in two or three years. Where several leaves are killed, the twig may be much weakened or die. Black pit consists of dark, sunken spots in the rind of the fruit. They do not decay. Grow bushy, compact trees and avoid severe pruning. Protect the orchard with windbreaks against prevailing rain storms. For northern California conditions, on young trees, spray from October to December with bordeaux or ammoniacal copper carbonate.

Blue Mold, Green Mold, Penicillium spp.—The entire fruit rots, starting in spots and becoming a powdery blue or green, and gray. Avoid even minutest injuries in picking and handling fruit.

A process of dipping the fruit in a solution of borax or sodium bicarbonate has recently received considerable attention and appears to have much promise for the control of green and blue molds. A 3 to 5 per cent solution is used for 4 minutes. This may be accomplished by providing an extra tank through which the fruit is passed. The solution should be partially rinsed off, and a final light spray may be provided for this purpose.

Brown Rot or Pythiacystis Rot, Pythiacystis citrophthora S. & S.—See also "Gummosis." This disease is distinct from brown rot of apricots or monilia rot. A rather light-brown rot of fruit occurs, causing only slight change in texture at first, but it develops rapidly and spreads by contact. There is a characteristic odor, and a slight surface mold in moist atmosphere. It develops in moist weather. When prevalent, spray the lower branches and ground beneath with bordeaux mixture prepared as in formula 13, but using 12 pounds bluestone and 12 pounds lime in 200 gallons. Straw mulch also is useful. Do not allow boxes of fruit to stand overnight in the orchard. Use bluestone in the wash water (formula 17), maintaining a constant strength of 1½ pounds to 1,000 gallons. Consult your farm advisor for special methods for keeping the strength of solution constant where alkaline water is used. Grade out very carefully all orchard-infected fruits before storing.

<sup>&</sup>lt;sup>6</sup> For a thorough treatise see references given in footnote 1, p. 1.

A more recent method is to allow the freshly picked fruits to stand in the house for 24 to 72 hours, then to wash in water heated to 115–120° Fahr. for about 5 minutes. Where sooty materials from smudging occur on the fruit, suitable washing materials may be added to the wash water.

Cottony Rot, Sclerotinia sclerotiorum (Lib.) Mass. (=S. libertiana Fckl.).—See "Stem Rot," under "Alfalfa," p. 2, and "Green Rot," under "Apricot," p. 12. This is a serious citrus fruit rot in storage locally after wet weather. A snow-white downy mold appears, causing a soft rot which spreads rapidly by contact. Twigs are sometimes killed. Treat as for brown rot, but the spores are much more resistant. See the farm advisor or consult the University of California, College of Agriculture, for details in control.

Other Citrus Fruit Rots.—Other citrus fruit rots which may be locally important are: Botrytis rot or gray rot due to Botrytis cinerea, a brown decay in which the fruits may finally be covered with a gray fuzz; Sour Rot caused by Oospora citri aurantii, a moist, soft, sour rot; Alternaria rot caused by Alternaria citri, a slow-working, black, powdery rot, mostly in the blossom end of navel oranges, occurring on the tree and causing premature ripening; Anthracnose rot, caused by Colletotrichum gloeosporiodes, a brown decay particularly following chilling or other injuries; Phomopsis stem-end rot, caused by Phomopsis californica, a withering and decay from the stem end, local in moist sections near the coast; Diplodia rot, due to Diplodia sp., similar to the preceding, but the fruits finally becoming much darker (stem-end rots are of prime importance in Florida and the West Indies but less so in California): Internal rot of lemons. Alternaria sp., a gradual weakening and browning and finally rot of the interior of weak fruit. (See Bul. 408.)

Some blemishes of importance are: **Brown Spot** of naval oranges, in which conspicuous, dark spots appear on the surface of the fruit usually on the way to market; **Peteca**, sunken spots in the rind of lemons; **Red Blotch**, extensive reddish brown areas on lemon fruit.

Damping-off.—See p. 79.

Decorticosis, or Shell Bark, Phomopsis californica Fawcett.—This disease is confined to the lemon; it resembles psorosis of orange, grapefruit, and some other fruits, but lacks the feature of gum flow; also the bark renews from below, so that finally a new, smooth bark is formed and the old bark sheds off. Trees are not killed, though they may be injured for a time. In the early stages treatment for psorosis may be applied. The best management for old cases is in doubt.

Gummosis, Phythiacystis citrophthora S. & S.—Gum is copiously exuded on the lower part of the trunk. The bark of the affected part dies and the diseased area may continue to spread until the tree is girdled and killed. Cut out all affected bark as soon as discovered and treat the wounds with bordeaux paste (formula 14, p. 114). Do not allow water to stand about the base of trees. In planting keep the point of budding well above ground and never allow the soil to pile up around the trunk. For heavy soil, use trees high-budded on sour orange root. See also p. 79.

Internal Decline of Lemons.—A gummy deterioration of fruits on the tree can be detected by experienced persons through lighter color of the green fruit. Fruit is inferior for keeping or using. It is apparently a drought effect. Where the trouble is serious, harvest and use the fruit as early as possible without waiting for growth to full size. Improve the moisture conditions if possible.

June Drop.—Young fruits up to nearly 1 inch in diameter turn pale and drop off. It is especially troublesome with navel oranges during severe hot periods. Any deficiency in vigor of the tree or of moisture supply in the soil will presumably make the trouble worse. Build up the vigor of the trees; secure the best possible moisture condition of the soil; plant windbreaks. Consult your farm advisor or local authorities.

Mottled Leaf.—Add as much organic matter to the soil as possible in the form of green-manure crops, bean straw, and manure. Avoid continual fertilization with nitrate of soda. See that water penetrates to the subsoil and keeps it moist. See p. 82.

Psorosis or Scaly Bark.—The bark at first becomes roughened in a small area; roughening spreads and deepens, finally gumming heavily, encircling the trunk or limb and causing its death. Scrape off the outer layers of bark, not only over the diseased spots, but for 4–6 inches beyond the edges of the visible affected area; leave the inner bark intact except where it has previously died. Cover the wounds with bordeaux paste (formula 14) or other suitable fungicide. Cut off badly affected branches. Watch all trees very closely in groves where the disease is present and eradicate new cases at first appearance. Do not use bordeaux if the trees are soon to be fumigated.

Wood Decay.—See p. 86.

Aphis (Various Species).—Use nicotine and soap or summer oil sprays (formula 41) or a 5 per cent nicotine dust.

Armyworms and Cutworms.—See p. 76.

Citrus Red Spider, Paratetranychus citri (McG.) and the Twospotted Mite, Tetranychus bimaculatus Harvey.—The first is bright cardinal red, while the two-spotted mite is yellow, pale green, or reddish and often has two or six dark spots on the dorsum. Dust with sulfur or spray with lime-sulfur 1-50 or wettable sulfur (formula 36), or commercial sulfur paste 10 pounds to 100 gallons of water or summer oil or white oil emulsions.

Citrus Thrips, Scirtothrips citri (Moult.).—Small pale-yellow insects less than ½0 inch long work on leaves and fruit. This insect is most satisfactorily controlled by a 2 per cent solution of commercial lime-sulfur. A combination of miscible oil and lime-sulfur is recommended by some for killing the gray citrus scale and the citrus thrips at the same time. Dusting with sulfur has also given good control of both insects in the San Joaquin Valley.

Fuller's Rose Weevil, Pantomorus godmani (Crotch).—A small gray snout beetle 3% inch long attacks young buds and foliage of citrus trees. The adults cannot fly and may be kept off the trees by cotton or tanglefoot bands around the trunks.

Mealybugs, *Pseudococcus* spp.—These small, flat, oval insects, covered with white mealy material, are well known to most citrus growers. They are difficult to control, but may be most satisfactorily handled by liberal applications of carbolic-acid emulsions (formulas 10 and 11), summer oil sprays and by miscible oils. Washing with water under heavy pressure has proved satisfactory under certain conditions. For the citrus mealybug, parasites are used with splendid results along the coast. The control of ants is necessary to secure beneficial results from parasites (see "Mealybugs," p. 80; and "Ants," p. 89).

Mediterranean Fruit Fly, Ceratitis capitata Wied.—This pest has not yet reached California, and a strict quarantine is maintained against it. For a description of the insect and a list of its possible hosts in California, see Experiment Station Circular 315.

Scale Insects (Many Species).—For control use fumigation with hydrocyanic acid gas or repeated and thorough applications of various strengths of distillate emulsions (formulas 24 and 27) or miscible oils or lubricating-oil emulsions. For the cottony cushion scale secure ladybird beetles from Citrus Experiment Station, Riverside, California.

# CORN

Boil Smut or Common Smut, *Ustilago zeae* (Beckm.) Ung.—Tender tissues of tassel, ear, or stalk swell into large soft masses, which dry out, becoming fragile and filled with black dust. This disease is often serious in California. Sometimes gathering up and destroying

the smutted stalks before the smut balls dry is recommended. Seed treatment is not effective. Rotation is perhaps useful. Diseased corn trash and manure are sources of infection. There are resistant varieties.

Ear Mold, Diplodia zeae (Schw.) Lev. and Fusarium sp.—The ears mold in the field, the kernels becoming crusted together and light. It is sometimes bad in late corn in shallow soil. Use early varieties. Harvest and cure as early as possible. Avoid over-irrigation. Select seed corn in the field, use only sound ears, and store in a dry place. Test each ear by germinating several kernels, and reject all ears not showing good germination. Several methods are available; one is to place the kernels with the numbers of the respective ears on a thick cloth, roll up the cloth, moisten, keep in a warm place for several days and count for percentage of germination.

**Head Smut,** Sphacelotheca reiliana (Kühn) Clint.—The ear and the whole top of the plant are affected. The whole plant is reduced in size and no grain is produced. No satisfactory control is known.

Rust, Puccinia sorghi Schw.—Small reddish pustules (sori) appear on the lower leaves, causing them to become reddish-dusty and in severe cases to dry prematurely. No control is available.

Angoumois Grain Moth.—See "Grain," p. 41.

Armyworms and Cutworms.—See p. 76.

Corn Earworm, Chloridea obsoleta (Fab.).—The larvae are nearly 2 inches long when full grown and vary in color from yellowish to brownish, with longitudinal gray and white stripes and with eight small dark tubercles on each segment. They work chiefly on the corn in the ear, but they may also attack the tassels and leaves. Clean up and burn refuse in the field. Plow in fall or early spring to expose and kill the pupae. Repeated dusting of ears with powdered arsenate of lead one part to four parts of hydrated lime gives some relief.

Granary and Rice Weevils.—See "Grain," p. 42.

Grasshoppers.—See p. 79.

Wireworms.—See p. 85.

# COTTON

Cotton Boll Decay, Aspergillus niger Van Tieg. and Rhizopus nigricans Ehr.—The initial stages are plainly those of a soft decay. Later stages show a drying up of the tissue that slightly resembles smut, which accounts for the term 'smut' applied by growers. There are two forms of the disease caused by the two fungi named above.

They may be readily distinguished by the discoloration of the affected tissues. Inasmuch as infection in the field apparently depends on injuries caused by various insects, control measures will have to be directed against these insects.

Sore-Shin, Rhizoctonia sp.—This disease is characterized by the presence of dark reddish-brown sunken cankers at or just below the surface of the soil. These lesions may encircle the stem and penetrate so deeply that the plants fall over and die. Some may partially recover but frequently make inferior plants. No very satisfactory control methods are known. Fertilize adequately to start the plants off with a vigorous growth and cultivate to allow the soil near the plants to dry out after a wet period.

Texas Root Rot, Phymatotrichum omnivorium (Shear) Duggar.— The first indication of this disease is the sudden wilting of the plants, commonly without any previous dwarfing or other symptoms. On removal of the plant from the soil, infected plants show the causal fungus on the surface of the roots as tawny strands or threads. The cortex of the root is soft and readily peels off. Any suspected case should be reported at once to the Experiment Station. Many crop plants are susceptible, such as soy beans, cowpeas, sweet potatoes, alfalfa, most nursery stock and fruit trees, many shade trees, and vegetables. The grains are immune. Rotation and deep fall plowing are the best known methods of control.

Armyworms and Cutworms.—See p. 76.

Bean Thrips.—See "Bean," p. 19. This insect usually appears on the cotton late in the season, when the injury is not of sufficient importance to justify control. Early infestation should be promptly dealt with, using dusting sulfur.

Corn Earworm.—See "Corn," p. 34. This insect attacks the cotton bolls. Sweet corn is sometimes planted as a catch crop. Dusting with powdered arsenate of lead or calcium arsenate gives good results.

Cotton Leaf Perforator, Bucculatrix thurberiella Busck.—The larvae are pale or dark greenish and less than ½ inch long. When disturbed they wriggle violently. They perforate the leaves with very many holes so as to almost entirely consume them. The larvae pupate in small, white-ribbed cocoons attached to the leaves or stems of the plants. The adults are white with black dots and other black markings.

This insect normally feeds upon wild cotton, but in recent years has invaded the cotton belt of the Southwest, and, while it prefers weak plants, it will attack perfectly healthy ones as well.

Parasites do much to keep the insect in check, but where severe infestations occur dust plants with calcium arsenate. From 20 to 30 pounds are sufficient for an aere of cotton.

Red Spider and Two-spotted Mite.—See "Bean," p. 19.

## CUCUMBER

Mildew, Erysiphe cichoracearum D. C. (= Oidium).—Fine white mycelium covers the leaves. Dust with sulfur at first appearance or with sulfur nicotine dust if the melon aphis is also present. Severe injury may result if sulfur is applied at temperatures of 95° Fahr. and above.

Flea Beetles (Various Species).—These are small flea-like beetles which jump quickly and eat small holes in the leaves. Bordeaux mixture (formula 13) as a repellent is a good control measure. This treatment is also recommended for mildew. Also dust with 1 part of 5 per cent nicotine dust and 1 part of arsenate of lead or with 70% sodium fluosilicate dust.

Garden Nematode.—See p. 82.

Melon Aphis.—See "Melons," p. 47.

Red Spider and Two-spotted Mite.—See "Bean," p. 18.

Western Twelve-spotted and Striped Cucumber Beetles, Diabrotica soror Lee, and D. trivittata Mann.—The former is a small green beetle with twelve black spots on the back and is often mistaken for a ladybird; the latter is a brown beetle with three black lines on the dorsum. The white larvae feed upon the roots and may be controlled by pouring on the roots a cup of 40 per cent nicotine sulfate diluted 1 to 1,000 parts of water. Bordeaux mixture (formula 13) is of considerable value as a repellent. Arsenate of lead (formula 2) may also be used with good effect. The best insecticide now known for these beetles is 70% sodium fluosilicate dust.

# CURRANT, GOOSEBERRY

Combined Spraying.—Sulfur sprays will control both the mildew and the red spider. See "Mildew."

Mildew, Sphaerotheca mors-uvae (Schw.) B. & C.—A fine white mycelium grows over the young leaves and shoots and checks their development. It is serious on some varieties. The best treatment is to spray with lime-sulfur 1–33 when buds commence to open and two or three times thereafter at intervals of 10 to 14 days. When serious, cut and burn diseased tips of canes while dormant, as the fungus

winters on them. In California, where resistant varieties are used, a dormant spray of lime-sulfur 1-10, followed by dusting with sulfur when the disease first appears, has generally been effective.

Pine Blister Rust, Cronartium ribicola Fisch.—White pine blister rust is not yet known to exist in California but is established in British Columbia, Washington, and Oregon, and as its spores, formed on gooseberry and on currant, are widely wind borne it may be expected to reach this state in time. Currants and gooseberries are not seriously injured by this rust but they serve to furnish spores which infect white pines, including sugar pine and mountain white pine, to which it is finally fatal if currants, especially black currants, are near. Destruction of the cultivated black currant is being urged to help delay the introduction of this destructive fungus.

Currant or Gooseberry Fruit Fly, Epochra canadensis Loew.— Small white maggets occur in the fruit at picking time. Cultivate thoroughly during the fall, winter, and spring months to expose and destroy the hibernating pupae.

Imported Currant Borer, Aegeria tipuliformis Clerck.—White caterpillars nearly 1 inch long work down the middle of the stalks and into the roots of the plants. Cut out and burn all dead and infested canes during winter and remove the borers.

Red Spider and Two-spotted Mite.—See "Bean," p. 19. Dust with sulfur or spray with wettable sulfur (formula 40) or sulfur paste (formula 35).

San Jose Scale.—See "Apple," p. 9.

Western Flat-headed Borer.—See "Apple," p. 9.

#### DAHLIA

**Mildew**, *Erysiphe* sp.—White spots spread over lower leaves. It is not serious. Dust with sulfur.

Bean Aphis.—See "Bean," p. 18.

Western Twelve-spotted Cucumber Beetle.—See "Cucumber," p. 36.

Wireworms.—See p. 85.

#### DATE

Date Leaf Smut, Graphiola phoenicis (Moug.) Poit.—Small dark bodies appear on the mature leaves and later turn yellowish gray; where they are very numerous, the leaf becomes unsightly and dries prematurely. Ornamental and fruit-bearing dates are affected. Moist atmosphere favors the disease. Control apparently has not been

studied, but where desired a clean-up might be tried by removing all visibly affected leaves and spraying thoroughly one or more times with bordeaux mixture.

Date Palm Scale, Parlatoria blanchardi (Targ.)—A small gray and white scale, less than ½6 inch long, often occurs in great numbers on the leaves. It may be controlled by cutting away and destroying all the leaves, burning over the trunk with a gasoline torch. Offshoots are cleaned up by heavy fumigations with hydrocyanic-acid gas. This insect is quarantined by the Federal Horticultural Board, and young plants may be obtained only from uninfested territory.

Dried Fruit Beetle.—See "Prune," p. 62.

Indian Meal Moth.—See "Prune," p. 62. This insect is a serious pest to dried dates, and to avoid infestation by this insect dates should be packed only in insect-proof containers.

Red Date Scale, Phoenicococcus marlatti Ckll.—A red-bodied, cottony covered scale, considerably larger than the date palm scale. It is chiefly found in the unfolding leaves, often so protected as to be almost impossible of control. Fumigating and burning over the trunks and treating liberally with carbolic acid and oil emulsions give some control, but eradication on a tree once thoroughly infested is apparently impossible. This pest is also under federal quarantine, and new plants may be obtained only from uninfested territory.

Red Spider.—See "Citrus Red Spider," p. 62.

### **FERNS**

Black Scale and Plant Lice.—Dip the plant frequently in a solution of 40 per cent nicotine sulfate, 1 part to 600 parts of water.

### FIG

**Dropping of Fruit.**—This is usually due to lack of caprification by the minute fig wasp bringing pollen to the flowers from the wild or Capri fig. It applies only to certain varieties such as the Calimyrna. Consult literature on fig culture and authorities on the subject.

**Smut**, Aspergillus niger Van Tieg. (= Sterigmatocystis ficuum (Reich.) Henn.).—In extreme cases the dried fruit is merely a shell filled with purplish black dry powder which may be puffed out. There are all gradations to the condition in which the interior of the fig is merely slightly darkened. It is caused by one of our commonest molds.

Infection occurs in ripening fruit; if at an early stage, the fruit rots, if later, it is harvested. It does not develop in the stored dry figs. The fungus, with other molds, is introduced into the figs by the dried fruit beetle *Carpophilus hemipterus* (Linn.) and possibly by thrips.

Soft Rot or Endosepsis, Fusarium moniliforme Sheldon.—A soft rot of the inside of caprified figs, without fermentation or souring and with a bright pink-colored area around the eye of the fig. It is caused by a delicate white mold, the spores of which are carried by the fig wasp, Blastophaga psenes L. and deposited in the green figs. The mold develops slowly in the green fig and more rapidly as the fruit ripens, and causes more or less complete decomposition of the ripe fruit. It is controlled by splitting open the mamme figs and dipping them in a fungicide.

Souring.—Fruits become sour and fermented on the trees. It is caused by yeasts, which are largely introduced into the fruits by the dried fruit beetle *Carpophilus hemipterus* (Linn.) and the vinegar fly (sometimes called fruit fly) *Drosophila ampelophila* Loew. Promising measures for control consist in the disposal of all fruit and similar material in which the insects may breed and over-winter.

**Splitting.**—Splitting is due to unfavorable atmospheric and soilmoisture conditions.

Twig Blight.—This is caused to a limited extent by *Sclerotinia* sclerotiorum and *Botrytis cinerea*. Frost is often injurious to young trees which make late growth (see p. 79). None of these appears to be serious.

Branch and Twig Borer.—See "Apricot," p. 13.

Dried Fruit Beetle.—See "Prune," p. 62.

Mediterranean Fig Scale, Lepidosaphes ficus (Sign.).—Scales resemble small oysters and infest the limbs, twigs, leaves, and fruit. Spray with distillate emulsion (formula 27), miscible oil, or crude-oil emulsion (formula 22) during the winter when the trees are dormant.

Nematodes.—These are becoming increasingly serious. No remedy is known. See p. 81.

Pomace or Vinegar Fly, Drosophila ampelophila Loew.—Small, slender, whitish maggets and brown or orange-colored flies  $\frac{1}{10}$  inch long, often occurring in great numbers in figs on the trees and on the drying trays. No practical method of control has yet been devised.

Red Spider.—See "Citrus Red Spider," under "Plum, Prune," p. 62.

## GRAIN (Barley, Oats, Wheat, Rice, Grain Sorghums, Maize, Millet)

Rust, *Puccinia* spp.—Pustules of pinhead size, round or elongated, break through the surface of leaves and stems; they are mostly reddish at first and dusty; later black. Rust is serious in heavy grain in moist situations or seasons. No remedy is known, but resistant varieties may be used.

**Smut**, *Ustilago* spp. and *Tilletia* spp.—Smuts of cereals include (1) loose and (2) covered or hidden smuts. The loose smuts attack wheat, barley, oats, maize, and sorghum (grain and sweet). For these the hot-water treatment is the most effective, but certain organic mercury compounds (Uspulun and Semesan) are efficient, more easily applied, and do not injure the seed. See p. 117.

Covered or hidden smuts include bunt, or stinking smut of wheat, covered smut of barley, hidden smut of oats, and kernel smut of sorghums, Sudan grass, and millet. Only bunt gives off an offensive Seed of wheat, barley, oats, Sudan grass, millet, and sorghum should be carefully cleaned of smut balls, weed seeds, and small, cracked, and inferior grains before treating. The smut balls in wheat and smut masses in barley may be cleaned out in fanning mills or floated out in water and skimmed off. Place the cleaned seed in half-filled sacks tied at the end. Immerse these sacks for 3 or 4 minutes in a bluestone solution made by dissolving 1 pound of bluestone in 5 gallons of water (formula 16). Drain the sacks until dripping no longer occurs, then dip them for 3 minutes in a milk of lime made by slaking 1 pound of quicklime in 10 gallons of water. prevents injury to the germ from bluestone. If quicklime cannot be secured, air-slaked lime, 1 pound to 8 gallons of water, may be used. After this treatment the grain should be spread out to dry, after which it may be planted or stored.

Oats are especially sensitive to bluestone, and for them it is better to use a solution of formaldehyde, 1 pound to 40 gallons of water, for 10 minutes. After this no lime dip is needed. Barley is more sensitive than wheat and should always be lime-dipped after treatment with bluestone.

Seed scratched or injured in threshing should be limed after dipping in bluestone solutions. Scoured seeds should not be dipped in any fungicidal solution.

Seed wheat and barley to be sown in dry ground or to be stored longer than 48 hours must not be treated with formaldehyde, as severe injury may follow.

If foggy or rainy weather is likely to interfere with the proper drying of lime-treated seed, injury from heating may be avoided by soaking the seed for 10 or 15 minutes in water before dipping in the bluestone solution. The lime dip may then be omitted.

Copper-carbonate dust has been highly successful in controlling bunt covered smut of barley, and kernel smut of grain sorghum (see p. 40), but is not so successful with loose smuts. The copper-carbonate dust does not cause seed injury. Dusted seed may be stored dry for long periods without chemical or insect injury to seed. Mice are repelled but may attack the seed if sufficiently starved. A number of serviceable machines for applying the dust are on the market. Finely powdered bluestone used at the same rate as copper carbonate also gives good smut control, but is not equal to copper carbonate, for seed injury may occur in badly scratched or broken seed.

Loose smuts of wheat and sorghum cannot be controlled by the above treatment. Loose smuts of oats and barley are destroyed by formaldehyde solution (1 pint to 30 gallons of water), soaking for 10 minutes or by Semesan or Ceresan solution or dusts. Kernel smut of sorghums and Sudan grass is controlled by soaking the seed in formaldehyde solution, as above, for 30 minutes for grain sorghums and 60 to 90 minutes for sweet sorghums and Sudan grass. Ergot of rye and rye grass is controlled by floating off the ergots in a strong brine solution (40 pounds of salt in 25 gallons water) and rinsing with clear water, or by holding the seed for a year before sowing.

Hot-water treatment to control diseases carried within the seeds is as follows: Presoak the seed in tepid water for 15 hours or overnight and soak in hot water at 130° Fahr. for 15 minutes. This treatment kills all fungus spores connected with seed. Seeds brought into this state might well be given this treatment to insure against introduction of foreign diseases.

Angoumois Grain Moth, Sitotroga cerealella Oliv.—A small tawny moth is found in granaries. The pale-yellow caterpillars feed within the kernels of stored grain and corn, escaping through a round hole. Control measures are the same as for the granary and rice weevils. See below.

Aphis (Many Species).—Aphis often seriously attack grain. Control methods are usually too costly to be practical. Cutting is often resorted to in order to save part of the crop.

Armyworms and Cutworms.—See p. 76-78.

Grain Mites, Tyroglyphus spp.—Pale-colored mites, smaller than the point of a pin. Frequently found in stored grain and by-products.

When abundant, they appear as loose, fluffy masses of gray powder, for the cast skins are mingled with the living mites. Heat is the most effective remedy and should be used if practical. (see "Heat as an Insecticide and Disinfectant," p. 116). Fumigation with carbon disulfide may also be used. Screening or fanning may reduce the infestation to a satisfactory degree.

Granary Weevil, Sitophilus granarius (Linn.), and Rice Weevil, S. oryza (Linn.).—Small brown or black weevils not over ½ inch in length, attacking the grain in storage. Fumigate with carbon disulfide 10 to 30 pounds to 1,000 cubic feet of air space, according to the tightness of the container. The temperature must be at least 70° Fahr. for satisfactory results. Hydrocyanic-acid gas may also be used as a fumigant, in which case from 1 to 4 ounces of pure sodium cyanide to 100 cubic feet of air space should be used. Heating the grain to 125° Fahr. for several hours will kill all the weevils. Keeping the grain dry and well ventilated will largely prevent weevil attack in storage. Seed grain treated with copper-carbonate dust as recommended for smut will remain free from weevil attacks.

Grasshoppers.—See p. 79.

# GRAPE, RAISIN

Coulure.—In certain varieties, notably Muscat, the flowers sometimes fail to set fruit. Interplanting with other varieties to improve pollination is recommendation. Also vigorous sulfuring during blossoming to prevent mildew favors the setting of fruit.

Crown Gall, or Black Knot, Bacterium tumefaciens S. and T.—Rough galls form on canes and trunks above ground; they are often serious. Girdled stems become weakened and die. This trouble is bad in cold situations and after frosty seasons. If spoiled parts are removed in time, new shoots will grow up from below. Control has not been worked out, but something can be done by surgery. Bordeaux spray in winter should be tried as preventive. See p. 78.

Little Leaf, Apoplexy, Black Measles, Obscure Diseases.—See "Physiological Diseases," p. 82.

For certain of these troubles, especially that known as 'black measles' excellent results have been secured by spraying or swabbing the vines while dormant with 2 or 3 pounds of sodium arsenate in 50 gallons of water.

Mildew, Uncinula necator (Schw.) Burr.—White mycelium spreads over young leaves, canes, and fruits, checking growth; the

leaves are deformed and may drop; the surface of the fruit hardens and darkens and the fruit often cracks, or may drop. Dust with sulfur when the shoots are about 6 inches long and again just before the blossoms open, being careful not to miss a single leaf. If the vines were affected the previous year do not wait until the mildew appears. In cool or moist locations a third sulfuring when the grapes are as large as peas and a fourth when they are two-thirds grown may be necessary. In these later treatments the sulfur should be dusted only on the fruit and the centers of the vines. If the larvae of leaf-hoppers are present use nico-sulfur instead of sulfur. (See Ext. Cir. 31.)

Achemon Sphinx Moth, Pholus achemon (Drury).—The large caterpillars are green and pinkish with oblique whitish bars on the sides. They are often abundant and do great damage by stripping the vines. The adult moths are dull gray with brown marks and pink hind wings. Spray vines with arsenate of lead (formula 2), to which is added 1 pint of 40 per cent nicotine sulfate to every 200 gallons, or dust with powdered arsenate of lead, 1 part to 4 parts of hydrated lime or flowers of sulfur.

Armyworms and Cutworms.—See p. 76.

Grape Mealybug, Pseudococcus maritimus Ehr. (=P. bakeri Essig).—Easily distinguished by the small, oval, flat bodies covered with white cotton-like wax and by the cottony egg masses among the bunches of grapes. It is difficult of control, but best results have been obtained by using the miscible oil sprays during the winter months. See also "Mealybugs," p. 80, and "Pear," p. 59.

California Grape Root Worm, Adoxus obscurus (Linn.).—The adult beetles are black or brown and  $^{3}\!_{16}$  inch long. They eat long slender holes in the leaves. The small white grubs feed on the roots of the vines. Cultivate thoroughly close to the vines during the winter to kill hibernating larvae. As soon as the beetles appear in the spring, spray with arsenate of lead, 6 pounds of paste or 3 pounds of powder to 100 gallons of water, or dust with 1 part of powdered arsenate of lead to 4 parts of hydrated lime or sulfur.

**Dried Fruit Beetle.**—These are frequently found on raisins; see "Plum, Prune," p. 62.

Grape Leafhopper, Erythroneura comes (Say).—The immature forms or nymphs are white or pale yellow, while the adults are pale yellow with numerous small reddish marks all over the dorsum. All forms feed on the under side of the leaves, causing them to turn yellow and drop prematurely. Clear weeds and refuse from around

the vineyards and practice clean culture to reduce the number of over-wintering adults. Before the young nymphs develop wings spray thoroughly with nicotine and soap (formula 41), or with the following: 40 per cent nicotine sulfate, 1 pound; liquid soap, ½ gallon (hard soap, 2 pounds) water, 200 gallons or with a pyrethrum-oil spray. The young and adults may also be killed by thoroughly dusting with 50 per cent calcium cyanide dust or with a 10 per cent nicotine dust, or a 6 per cent nico-sulfur dust; the latter will also control mildew.

Grape Phylloxera, Phylloxera vitifoliae Fitch.—The presence of the phylloxera is indicated by weak and dying vines. It usually occurs in spots. The insect is a minute, yellow louse which feeds on the roots. To disinfect cuttings or rootings before planting, dip in hot water 122° Fahr. for 5 minutes. For permanently resistant vines, graft European varieties on certain American roots.

Grasshoppers.—See p. 79.

Indian Meal Moth.—This moth sometimes attacks raisins; see "Plum, Prune," p. 62.

**GRAPEFRUIT**—See "Citrus Fruits," p. 30

## HOLLYHOCK

Rust, Puccinia malvacearum Mont.—Prominent red sori or pustules push out on the lower surface of the leaves and on petioles and stems, often causing distortion. Fertilize and water freely to promote vigorous growth.

Destroy all old plants and start anew from seed at least every two years. Some strains appear to be resistant.

Painted Lady Butterfly, Vanessa carye Hbn.—The yellowish or black spiny caterpillars which are about 1 inch long, feed on the leaves, which they draw together with webs for protection. Control is best accomplished by using 40 per cent nicotine sulfate, 1 part to 600 parts of water, and spraying the plants thoroughly.

### HOP

Hop Aphis, *Phorodon humuli* (Schr.).—A pale-green aphis attacking the young shoots and leaves. Dust thoroughly and as often as necessary with 5 per cent nicotine dust or spray until injury ceases with nicotine and soap (formula 41).

Hop Flea Beetle, Psylliodes punctulata Mels.—A small green or bronze metallic beetle, ½0 inch long, attacks the foliage. It jumps quickly when disturbed. The most efficient method of control consists in putting tanglefoot bands around the bases of the vines and around the poles. These not only prevent the beetles from climbing the vines but also catch great numbers of them.

Red Spiders and Two-spotted Mite.—See "Bean," p. 19.

## IRIS

Leaf Spot, or Fire, Heterosporium gracile Sacc.—Conspicuous dead spots appear on leaves and may cause death of the whole leaf. Certain varieties are particularly sensitive; others practically immune. Spanish iris and the Susiana types, are said to be very susceptible. Clean up thoroughly all old foliage before growth starts. Spray repeatedly with bordeaux (formula 13), containing spreader (p. 113) or formula 15, beginning when the foliage first appears, or if the stain of the bordeaux is objectionable use the ammonium copper carbonate (p. 115).

Iris Root Aphis, Anuraphis tulipae (Fonsc.).—A pale-green aphis covered with fine whitish powder infesting the stalks, bases of the leaves, the crowns, and the bulbs of irises and also bulbs of tulips and gladiolas. Use summer oil or nicotine sprays in the garden and fumigate infested bulbs with nicotine or cyanide dust before planting.

#### LAWNS

Brown Patch.—Considerable trouble has been experienced at various times with dying-out spots in lawns, but these troubles have not been satisfactorily worked out in this state. In the East, two forms of brown patch have been described, caused by two species of *Rhizoctonia*. In one, leaves are killed over spots a foot or more in diameter; in the other, spots about an inch in diameter are entirely killed. Spraying with the organic mercury compounds (see p. 117) has given good results with brown-patch diseases. Conditions must be made favorable; excessive moisture must be avoided. Kentucky blue grass is said to be immune to brown patch.

Earthworms.—Earthworms or angle worms frequently cover golf greens with casts of earth, which are undesirable in such a place. To cause the worms to come to the surface, apply mercuric chloride, mixed as follows, and then sweep up the worms and remove them:—

1 lb. corrosive sublimate.

1 gallon boiling water.

Let cool for one hour; then add 4 gallons of cold water. Use  $2\frac{1}{2}$  pints of this solution to a barrel of water, and apply to greens with a sprinkler. See p. 117 for precautions in the use of mercuric chloride. This is a dangerous poison.

Weeds.—Fertilize well. Use a solution of nitrate of soda, strong enough to kill the tops but not the roots—about 3 to 5 pounds to 100 gallons of water, according to the kind of grasses in the lawn.

LEMON—See "Citrus Fruits," p. 30

#### LETTUCE

Brown Blight.—This is a destructive disease in which plants, if attacked early, die or become brown streaked and stunted, and form a loose rosette in place of a head. If attacked late, brown streaks appear in the head. Do not plant lettuce on land where the disease has appeared, unless resistant varieties are used. It occurs only in the extreme southeastern part of the state and adjacent territory.

Downy Mildew, Bremia lactucae Regel.—Pale spots appear on the lower leaves with a white mold on the lower surface. Later the spots turn brown and are liable to infection with Botrytis or other organisms giving 'slime' or decay in distant shipment. More active in the moist winter season.

Slime, principally *Botrytis cinerea* Pers.—Moist rot is likely to develop in the field or in shipment and progress extensively through the head. Any sort of defect, or injured tissue, such as is produced by tip-burn, may serve as a starting point for this rot. Excess moisture, as caused by flooding the plants, is favorable to the disease.

Tip-burn.—Dead areas appear along the edges of young, exposed leaves, and on those in the head. May be controlled in greenhouse culture by skill in watering and ventilating to prevent too succulent a growth. The trouble appears in California mainly with warmer weather, and is a very difficult disease to control under California conditions, but is prevented to some extent by the use of resistant varieties.

Armyworms and Cutworms.—See p. 76.

# LOQUAT

**Pear Blight,** Bacillus amylovorus (Burr.) Detoni.—Limb and body blight is sometimes very severe. See "Pear," p. 57.

Scab, Fusicladium eryobotryae Sciala.—Scab on loquat resembles scab of pear and apple, but is more injurious to expanding foliage

(see "Pear," p. 59). Control is not developed, but sprays for pear in foliage may be used.

Green Apple Aphis.—See "Apple," p. 8. San Jose Scale.—See "Apple," p. 9.

# MELONS (Casaba, Cantaloupe, Pumpkin, Squash, Watermelon)

Blight Macrosporium cucumerinum E. & E.—Spots up to ½ inch in diameter appear thickly on the leaves, die, and turn dark. The effect is somewhat similar to that of downy mildew. Situations where the disease has occurred should be avoided for melons for at least a year. The spray program recommended for downy mildew may be used. The disease is a severe one and difficult to control in moist districts.

**Blossom End Rot.**—This is presumably associated with soil or climatic conditions, and is sometimes severe. There is indication of resistance in some varieties.

Downy Mildew, Peronoplasmopora cubensis (B. & C.) Clint.—Yellowish angular spots appear on the leaves, which soon wither and dry. First the center of the hill is defoliated and finally the whole field. Cucumbers, cantaloupes and other melons, and similar plants are affected. The disease is rare in California, but in exceptionally moist springs may do harm. Treatment in eastern states consists of spraying with bordeaux mixture beginning when the plants start to run and continuing at regular intervals using a 3–6–50 formula first and later 4–4–50. It might be well to be on the alert in California, and if the disease appears to spray promptly. Special arrangement and care of fields and suitable apparatus are necessary where the usual spray program is carried out. It is important to cover the lower surface of the leaves.

This should not be confused with the powdery mildew, which has caused serious injury to cantaloupes in interior districts of southern California. This trouble is being actively studied by the Citrus Experiment Station and it is hoped that control measures may soon be developed.

**Powdery Mildew,** Erysiphe cechoracearum D. C.—Fine white mycelium appears on the leaves and petioles, except on watermelons, in spots which may coalesce and cover the surface. Dust with sulfur, provided the temperature does not exceed 95° Fahr., above which point injury to the plants may result.

Wilt, Fusarium sp.—Well-grown watermelon plants wilt and die, leaving the field nearly bare. Plant on fresh soil. Watermelons can-

not be grown for several years on infected ground. Other melons are not often, if ever, affected in California.

Flea Beetles.—See "Cucumber," p. 36.

Melon Aphis, Aphis gossypii Glover.—A small, very dark-green louse occurs in great numbers on the plants and does great damage. Destroy the first infested plants as soon as discovered in spring or spray with nicotine sulfate, 40 per cent, 1 part to 1,000 parts of water. A 5 per cent nicotine dust also gives very good results and is much more easily and quickly applied.

Nematode.—See p. 81.

Squash Bug, Anasa tristis DeGeer.—The young bugs are gray with black antennae, legs, and thorax; the adults of a uniform dull grayish-brown above, mottled yellowish beneath, and about ¾ inch long. Control measures should be directed against the immature forms, and consist in the use of 1 part of Black Leaf 40 to 600 parts of water. A 50 per cent calcium cyanide dust is most effective. Handpicking the adults in the spring is successful in small gardens.

Western Twelve-spotted and Striped Cucumber Beetles.—See "Cucumber," p. 36.

#### NURSERY STOCK

Crown Gall.—Avoid planting affected trees. If a large percentage of a plot of trees is affected, those apparently healthy are of doubtful value. See p. 78.

Failure to Grow after Planting in Orchard.—This is very rarely due to specific disease; it is usually caused by freezing, drying, or water-soaking of trees before or after planting; planting too deep; cold, wet, or hot weather after planting; or some other condition unfavorable to growth. Bare roots are very sensitive to slight freezing and injured trees at best start tardily and grow in a sickly way. Buy from the nearest reputable nursery. Pay for good trees and see that they are handled and planted carefully. Replant all that do not grow well the first season.

Pythiacystis Canker, Pythiacystis citrophthora S. & S.—Dead spots up to several inches long develop on the trunk or branches, mostly above the bud union. They are caused by soil infection under very wet conditions. Spray trees with bordeaux mixture before digging and after heeling-in. Soil for heeling-in should be well drained or under cover. The cankers are active only in very wet seasons.

Borers and Other Insects on Deciduous Stock.—Fumigate with hydrocyanic-acid gas. Rejecting infested stock is the only safe procedure.

**Nematode.**—Very carefully avoid planting affected trees. If a large percentage of a plot of trees is affected, those apparently healthy are of doubtful value. See p. 81.

Scale Insects.—For scale insects on citrus nursery stock, defoliate and fumigate with hydrocyanic-acid gas (see p. 117), or dip in solutions of summer oil. Rejecting infested stock is the only safe procedure.

OATS—See "Grain," p. 40

### OLIVE

Armillaria Root Rot.—See p. 76.

Die-back, or Exanthema.—The bushy phase is characterized by repeated death of terminal buds and branching out below; leaves show deformities. In the die-back phase there is usually dropsy-like puffing of bark on branches and limbs and unusual prominence of lenticels in the smooth bark, with dying-back. Secure uniform moisture and good drainage. Add organic material to the soil by greenmanure crops, mulch, or manure. Treatment along the lines indicated is reported as successful by the County Agent in Sacramento County, for mild cases. Replace olives with plums, peaches, or other crop where die-back is very bad. See "Physiological Diseases," p. 82.

Dry Rot, Bitter Pit, Sheep Nose, Monkey Face.—Dry spots appear in the flesh of the fruit. They are usually associated with conditions favoring exceptionally vigorous growth of the tree or large size of fruit, as in unusually fertile soils, on new grafts, on limbs girdled to increase size of fruit, etc. Management calculated to give only moderate growth may help. See "Physiological Diseases," p. 82.

Olive Knot, or Tuberculosis, Bacterium savastanoi E. F. Smith (= Pseudomonas oleae).—Rounded, rough swellings, from very small up to several inches in diameter, appear on twigs, limbs, trunks, or roots, mostly at leaf scars or wounds, also rarely on fruit pedicels and leaves. Cut out thoroughly at first appearance and disinfect. (See "Blight" under "Pear," p. 57, and "Crown Gall," p. 78.) The Mission is more resistant than the Manzanillo or some oil varieties.

**Peacock Spot,** Cycloconium oleaginum Cast.—Blackish round spots, ½ to ½ inch in diameter, occur on the surface of green leaves but do not kill the darkened area. It is apparently of very slight importance in California.

Soft Nose, Blue Nose, etc.—Ripe or nearly ripe, fruit turns bluish in a large area spreading from the blossom end. The spot at first looks much like a bruise. About one-half of the fruit very quickly turns dark and soon shrivels. It appears on the fruit on the tree, or during processing and affected fruit must be rejected. It has been reported on various extra-large varieties, but has been seen by Horne only on Sevillano, which appears to be affected in all districts. Is apparently not due to any parasite but to inherent weakness. Some evidence has been found that excessive irrigation and poor drainage tend to make the trouble worse. Fruit borne on young trees appears to be more susceptible than that on older trees. Severe some years, nearly absent in others.

Wood Decay.—See p. 86.

Black Scale, Saissetia oleae (Bern.).—See "Apricot," p. 13. This scale attacks chiefly the twigs. Spray with distillate emulsion (formula 26) or miscible oil or lubricating-oil emulsions, December to February.

Branch and Twig Borer, Polycaon confertus Lec.—See "Apricot," p. 13. This is often a serious pest of young olive trees.

Ivy or Oleander Scale, Aspidiotus hederae Vall.—A small circular, flat, gray scale occurs on the leaves and fruit, sometimes causing discolored spots on the ripening olives. Control as for black scale.

Olive Bark Beetle, Leperisinus californicus Swaine.—The small white larvae work in the cambium layer just under the bark and the adults bore small, round exit and entrance holes through the bark. It occurs in the southern part of the state. Burn prunings and remove all dead and infested portions of the trees.

## ONION

Black Mold, Aspergillus niger Van Tieg.—A black powder appears in spots and longitudinal streaks below the outer bulb scales usually in storage. Appearance, especially of white varieties, and keeping quality are impaired. It is sometimes called 'smut,' but there is also a serious disease of onions caused by one of the true smut fungi, which affects the leaves. Store only best bulbs, keep the temperature near 32° Fahr. and the air dry. If the trouble persists and is serious it is recommended to soak sets for six hours in formaldehyde solution, 1 pint in 30 gallons of water; or with seed, apply formaldehyde solution, 1 pint in 16 gallons of water in the furrow with the seed. Sixteen gallons should treat 3,000 feet of row, or 200 gallons per acre.

Downy Mildew, Peronospora schleideni Ung.—Areas on leaves or stems show a violet-tinted fuzz. These areas rapidly fade and collapse if the weather is moist, and the disease may spread rapidly. Spots on seed stalks cause these to break over and the seed heads are lost. It is not successfully controlled in wet seasons. Burn trash from affected crops after harvest, rotate crops. Bordeaux mixture has been found useful in some cases; it should be used with resin fish-oil soap or other spreader. See "Spreaders," p. 127.

**Pink Root**, *Phoma* sp.—Young plants are stunted and older plants are injured, bulb formation is interfered with, and the crop reduced. Roots diseased turn pink. Avoid infected soil, or if this is not entirely possible keep plants growing as well as possible at all times. Where plants are grown in a seedbed and transplanted, disinfect soil with formaldehyde or steam, p. 126.

**Scallions.**—Plants fail to form bulbs, the stalks remaining thick and green. This may be due to poor seed or to a check in growth. Plant at a suitable season so that development may be continuous. Cutting off seed stalks and breaking over tops when crop is maturing may help.

Storage Rot, Botrytis spp.—Dense gray tufts appear, usually about the neck or on injured parts and the bulbs rot rather rapidly. White varieties are more susceptible than colored. The greatest importance attaches to thorough curing so that the necks are well dried out.

Armyworms and Cutworms.—See p. 76.

Onion Maggot, Hylemyia antiqua (Meig.).—Small, white maggots attack the onions beneath the ground. Practice clean culture and destroy all refuse onions in the fall. Plow and cultivate thoroughly during winter and spring. For control use mercuric chloride as recommended for cabbage maggot (see "Cabbage," p. 25).

Onion Thrips, Thrips tabaci Lind.—Minute, slender, pale-yellow insects occur in great numbers on the leaves, causing them to turn gray and wither. Spray with 1 part of 40 per cent nicotine sulfate to 800 parts of water or apply 5 per cent nicotine dust.

Wireworms.—See p. 85.

ORANGE—See "Citrus Fruits," p. 30

PALMS—See also "Date," p. 37

Washingtonia Filifera Disease.—Considerable confusion appears to exist as to the names of the different forms of Washingtonia palms

growing in this state. The palm referred to is the one with stout trunk, large, somewhat pointed and glaucous leaves. This palm is dying over a wide area in central and southern California. A general decline of older parts of the top with rotting from the outside is observed, and *Penicillium roseum* Lk. is found with the advanced decay. Apparently it is associated with cold and winter moisture. It may be advisable to decrease planting of this species until further information is available as to control.

### PEA

Bacterial Blight or Bacteriosis, Pseudomonas pisi Sack.—Extensive, watery, olive-green blisters appear on stems and leaf bases in wet weather, following cold. Some affected areas dry up, others kill the stem. Where the injury does not go too far down, new stems grow from below. In some wet situations practically every plant has been killed. Control has not been developed, but the trouble is worse in cold, wet conditions.

Blight or Spot, Mycosphaerella pinodes Berk. & Blox. (=Ascochytapisi Lib.).—Sunken dead spots form on pods, leaves, and stems, ½ inch or less in diameter; the center of the spot on the pod becomes gray or pinkish, with a dark border; leaf and steam spots are more often merely dark. Young stems may be killed. Experiments indicate that spraying is impractical. Keep pea crop and diseased material off the land for two years. Avoid too low, wet land. Seed infection is rare in California.

**Downy Mildew**, *Peronospora trifoliorum* De Bary.—This resembles downy mildew of alfalfa. It is common at the close of the rainy season, but apparently not serious.

Mildew or Powdery Mildew, Erysiphe polygoni D. C.—Powdery white growth spreads over the foliage, injuring plants. It is trouble-some in summer or when rains are light or lacking. Dust with sulfur on first appearance or nicosulfur dust if aphids are abundant, and repeat if necessary.

Armyworms and Cutworms.—See p. 76.

**Pea Aphis,** *Illinoia pisi* (Kalt.).—A large green aphid attacks the terminal shoots and leaves of the vines. It is difficult of control because of the expense involved, but may be killed by repeated applications of a 10 per cent nicotine dust or a nicotine spray (formula 42) or a 6 per cent nicosulfur dust to control mildew also.

Pea Weevil, Mylabris pisorum Linn.—A small gray and white weevil attacking the pea, much as the bean weevil attacks the bean,

but the pea weevil infests the peas in the field and the adults do not emerge until the following spring. Unlike the bean weevil it never reinfests stored peas. Treatment is the same as for bean weevil (see "Bean," p. 19).

### PEACH

Combined Spraying.—Two applications of lime-sulfur as recommended for peach blight will control all of the usual diseases and pests of the peach in California which can be reached by any spray treatment, but lime-sulfur has occasionally been reported as causing injury when applied in the bloom and may not be effective for control of leaf curl when applied late.

Armillaria Root Rot.—See p. 76.

Brown Rot, Sclerotinia cinerea (Bon.) Schröt.—See "Apricot," p. 11. Decay of late-ripening fruit sometimes is caused in moist regions near the coast. Control for the fruit-rot stage recommended in eastern states consists of spraying with self-boiled lime-sulfur (formula 38). The last application should be made a month or more before picking so that the stain will not remain on the ripe fruit. The twig-blight phase also occurs, but less abundantly than on apricot.

Crown Gall.—See p. 78.

Leaf Curl, Taphrina deformans (Fckl.) Tul.—Young leaves are attacked and become much thickened and ruffled. Tips of shoots are sometimes similarly affected and sometimes areas on fruit. Affected tissue is light or highly colored; it becomes powdery white and dies early in the summer. Trees may be injured by loss of foliage. Sprays for peach blight should control this, or if blight is not present, only the spring application need be made. Some failures in control may be due to too late application of spray.

Little Leaf.—See "Physiological Diseases," p. 82.

Peach Blight, Coryneum beijerinckii Oud.—See also "Bud Blight" under "Apricot," p. 12, and "Shot-Hole" under "Almond," p. 4. Buds are killed during winter, sunken round spots are killed in one-year twigs, and in spring a shot-hole effect appears on young leaves; later the twig spots gum profusely and gradually heal over unless the twig is killed. Spots also occur on the fruit in districts where the disease is serious. It is very serious in interior valley and foothill districts in moist winters. Spray with bordeaux (formula 13), or lime-sulfur or the equivalent of dry lime-sulfur in 100 gallons of water, between November 15 and December 15. Repeat with lime-sulfur or bordeaux when buds swell and before first blossoms begin to open.

Peaches cannot be sprayed with these materials after the leaves appear without danger of serious injury.

Powdery Mildew, Sphaerotheca pannosa var. persicae (Wallr.) Lév.—Young foliage becomes covered with white powder and growth may be checked. Large powdery white areas may appear on the fruit and later turn dark and check. Spray with lime-sulfur, as for leaf curl. Prune to thin foliage. Dust with sulfur at first indication of mildew and repeat as necessary.

Rust, Tranzschelia punctata (Pers.) Arth. (=Puccinia pruni, Pers.).—Rust causes small yellow, angular spots on the leaves, usually in late summer and fall. Defoliation may result after severe infection. On some varieties and under some conditions the rust fungus carries over winter in the new wood and produces spores in early spring, which cause primary leaf infection and subsequently fruit infection. Small, round, sunken spots appear in the fruit during summer. These spots render lye-peeling practically impossible.

As a result of control experiments the following is suggested: For eradication, an early fall spray (October 15 to November 1) with lime-sulfur, 6 or 7 gallons to 100 gallons of water, or the equivalent of dry lime-sulfur, will be effective. A summer spray of dilute lime-sulfur, 1 gallon in 100 of water, or the equivalent of dry lime-sulfur applied in late May or early June will prevent the fruit infection. It occurs also on almond, apricot, and plum.

Wood Decay.—See p. 86.

Black Peach Aphis, Aphis persicae-niger Smith.—A shiny black aphis sometimes occurs in great numbers on the young tender shoots. Spray with nicotine and soap (formula 41) or dust with 5 per cent nicotine dust as soon as the insects appear.

Black Scale.—See "Brown Apricot Scale," under "Apricot," p. 13.

Branch and Twig Borer.—See "Apricot," p. 13.

Brown Apricot Scale.—See "Apricot," p. 13.

Cankerworms.—See p. 77.

Nematode.—See p. 81.

Pacific Peach Tree Borer, Aegeria opalescens Hy. Edw.—The white caterpillars, attaining a length of  $1\frac{1}{2}$  inches, burrow under the bark at the base of the trees, often extending their tunnels down into the bases of the main roots. They are often serious, and may completely girdle the trees. Dig out the worms carefully in the fall and spring and paint over the wounds with a good asphaltum paint. Use paradichlorobenzene in summer and fall (see p. 119).

**Peach Rust Mite,** Phyllocoptes cornutus Banks.—A microscopic mite causes a silvering of the leaves. Spray in winter when the trees are dormant or when buds swell in the spring with lime-sulfur, 1–10, to kill mites hibernating in buds.

Peach Twig Borer, Anarsia lineatella Zeller.—A small, dark-reddish caterpillar, scarcely ½ inch long, burrows into and kills the young tender tips of the twigs and, later on, may infest the fruit to some degree. The minute young forms hibernate in small cells in the bark and are effectively killed in the early spring of the year with lime-sulfur, 1–10, applied just as the blossom buds begin to open, which is before the larvae are able to enter the expanding leaf buds.

The following are the joint recommendations of the University of California and the California State Department of Agriculture:

Recent seasons have witnessed a decided increase in peach-twig-borer infestations in many of the large fruit-growing districts of California. Not only has greater injury occurred in peaches, but a growing hazard has developed in apricots, plums, prunes, and almonds. Growers have suffered heavy losses, and the wormy peach and apricot problem is of concern to canners. To the end that twig-borer losses may be successfully checked, a vigorous campaign by growers is advised.

An effective control of the spring brood will materially reduce later attacks on fruit. In order that this principle be taken advantage of to the fullest, thus eliminating summer sprays, thorough work in the spring is urged. Failure to spray both bearing and non-bearing trees or carelessness in application will contribute to individual loss, as well as damage the industry as a whole.

The standard control for the peach twig borer has for many years been delayed dormant lime-sulfur applied in the spring from the time the blossom buds are beginning to break until the first blossoms open. This spray program still holds good for most of the state for all stone fruits except apricots. In many orchards, however, considerable injury to the trees has been occasioned from the use of this spray, and complete control of the twig borer has not been obtained. A great deal of spraying during December and January has resulted in a noticeable amount of injury. Such injuries may be due to any of the following:

- 1. Using overstrength materials.
- 2. Using unreliable materials.
- 3. Spraying just after drying winds.
- 4. Spraying when trees are not completely dormant.

It is urged that more attention be given to avoiding the applications of sprays under unfavorable conditions.

Program No. 1.—This program is intended especially for peaches, but is equally satisfactory for almonds, nectarines, plums, and prunes. It is a combined spray for peach twig borer and the spring applications for peach blight and curl leaf.

Wherever lime-sulfur alone is desired as a spray for the peach twig borer use lime-sulfur (standard or 32° Baumé) 10 gallons, or an equivalent amount of dry lime-sulfur, to 100 gallons of water for completely dormant trees. Use from 6 to 8 gallons to 100 gallons of water.

Program No. 2.—For severe infestations of peach twig borer, where a more effective spray is desired, use lime-sulfur as above recommended with the addition of 3 pounds of dry basic arsenate of lead to 100 gallons of spray material.

Program No. 3.—Where bordeaux mixture is preferred, use the 5-5-50 formula plus dry basic arsenate of lead, 3 pounds to 100 gallons of the spray mixture.

This mixture is a combined insecticide and fungicide for the control of the peach twig borer and constitutes the spring spray for peach blight and curl leaf.

Important.—Summer sprays with arsenicals should not be applied without consultation with competent authorities.

Too much emphasis cannot be placed upon the necessity of proper spraying at the right time. It is essential to cover the entire surface of the tree, particularly the newer and outer portions of the branches. Use at least 175 pounds pressure, preferably 250 pounds.

All prunings should be collected and burned before spring, particularly the small and newer wood, because this material harbors the larvae.

Cull fruit should not be carelessly left about the orchard or packing house. All wormy fruit should be collected and properly disposed of. It should be fed promptly to pigs or other stock, or destroyed by burning or burying. A quick and simple manner of destroying worms in the cull fruit is to place the discarded fruit in a pile or in a trench, saturate with oil or cover with wood, and ignite. The heat resulting from the fire will be sufficient to kill the larvae in the fruit. Another means of destroying the larvae is to place the cull fruit in a caldron of boiling water for 15 minutes.

Use commercial lime-sulfur testing 32° Baumé. If stronger dilute accordingly.

Red Spider.—See "Plum, Prune," p. 62, and "Citrus Red Spider" under "Almond," p. 4.

San Jose Scale.—See "Apple," p. 9.

Shot-Hole Borer.—See "Lesser Shot-Hole Borer," under "Apricot," p. 13.

Tent Caterpillars.—See p. 84.

Western Flat-headed Borer.—See "Apple," p. 9.

Wheat Thrips, Frankliniella tritici (Fitch).—This minute orange and yellow thrips often does considerable damage to the young fruit at blossoming time and later. Control as for pear thrips; see "Pear," p. 60.

#### PEAR

Combined Spraying.—1. For scale of any kind and for moss and a general clean-up, use a winter spray of lime-sulfur, 1–10, crude-oil emulsion (formula 22), or miscible oil.

- 2. For scab and thrips use bordeaux mixture (formula 13), or lime-sulfur 1-12 as cluster buds are opening, adding an extra 10 pounds of lime and 1 pound of 40 per cent nicotine sulfate to each 200 gallons of spray. Oil sprays may be mixed with lime-sulfur or bordeaux mixture for this purpose.
- 3. For scab and thrips, repeat "2" when first blossoms are about to open.
- 4. For codling moth and late scab infection, spray when petals are falling with 4 pounds of powdered basic lead arsenate in 200 gallons of 1–30 lime-sulfur or 200 gallons of bordeaux mixture.

Black End.—The surface of the nearly mature fruit becomes hard and black in extensive areas about the blossom end. Before the black areas appear, affected Bartletts show the blossom end of the fruit smoothly rounded instead of undulate as is normal. It is presumably a physiological disease comparable to blossom-end rot of tomatoes. No recommendation can be made as yet except to give good care, especially as to drainage. Nearly all affected trees are found to be on Japanese or Japanese-hybrid stocks. In some places affected trees are being inarched with French or other stocks in the hope of overcoming the trouble.

Black Leaf, and Other Obscure Troubles.—Black leaf resembles blight in effect; the bark, however, is not reddish and juicy when cut into, but has dry black spots or areas. Shallow soil and summer drought appear to have particular significance in connection with this trouble. A peculiar condition sometimes develops on individual trees in which dark points develop in one-year bark. These persist and become hard, raised, and enlarged, until the whole surface may be much roughened and hardened ('pimply bark' or 'ring canker'). In certain dry soils in the south a peculiar drying-back of twigs occurs. The drying progresses to a certain point and new shoots start out below ('die-back' or 'exanthema'). Making the moisture supply of the soil more constant is believed to have greatly helped this last condition. See "Sour Sap," p. 83.

Blight, Bacillus amylovorus (Burr) Detoni.—Infection is spread mostly by insects. Tender growth and blossoms when infected become watery, darken rapidly, wilt and die; usually minute beads of gummy material exude; on larger branches the gumming is often more copious, but it may be lacking. The diseased bark may be recognized by cutting into it; watery, reddish, or somewhat dark-streaked areas indicate blight. Any part of the tree—top, body or root—may be attacked. The infection remains in the outer layers of bark for a week or more before penetrating to and killing the cambium layer.

Control is difficult but growers who thoroughly acquaint themselves with the disease and methods of control will have considerable success. Control consists in pruning off all affected blossoms, twigs, and branches, removing all off-season blossoms and treating chemically or surgically the new cankers which appear on the scaffolds, trunks, and root crowns. In order to keep ahead of the disease the orchard should be gone over at least once a week during the spring and summer in years when blight is common in the orchard. The shears and every wound made should be disinfected with the bichloride and cyanide of mercury disinfectant (formula 21). Keep close watch to check development of new infections, especially in off-season bloom occurring after the regular bloom or after the crop is harvested.

Winter work on cankers in large branches, trunks, and root crowns is very important, for these are the source of the first infections in the spring. The disease also holds over in a number of other plants, especially apple, quince, loquat, pyracanth, cotoneaster, and Christmas berry. Avoid severe pruning or cultural methods which stimulate succulent growth. Suckers and water-shoots about the trunk and scaffolds should not be removed during the blight season.

In new plantings in blight regions, graft the commercial variety onto resistant bodies. At present it is advised to use French roots with Old Home bodies.

Large branches, trunks, and root crowns may often be saved if the cankers are new, even if they extend all the way around. Two methods of arresting the cankers have been devised—a surgical process known as scarification and a chemical process. The chemical process is the most satisfactory of the two. It consists in applying a solution of zinc chloride to the cankers before they strike deep into the bark.

The scarification method consists in shaving off the diseased outer layer of bark and applying the mercury-glycerine disinfectant (formula 21).

No grower should attempt treating cankers by these methods without thoroughly familiarizing himself with the methods as outlined in Extension Circular 20, *Pear Blight Control in California*.

The following improvements in the zinc chloride method have developed since this circular was issued: On large branches the solution can be more thoroughly and quickly applied with an ordinary 2-ounce rubber bulb syringe, throwing a solid stream. A higher percentage of cure is secured on old branches if the dead scales are rubbed or scraped off before applying the 53 per cent solution—care being taken not to expose many spots of live bark. A 33 per cent solution

should be used on roots under  $2\frac{1}{2}$  or 3 inches in diameter, and 43 per cent on all roots larger than that. In some young orchards it is better to use a 33 per cent instead of 43 per cent solution on branches under  $2\frac{1}{2}$  or 3 inches in diameter, during the summer time. But before making this latter change the operator should make absolutely certain that death of the treated branches was not due to the canker, which may have been too old to cure, rather than to the strength of the zinc-chloride solution.

The 33 per cent solution of zinc chloride is made by adding to 1 quart of the 53 per cent solution, 1 quart of denatured alcohol, or better still, of the solvent given in Extension Circular 20.

Scab, Ventura pirina Aderh. (= Fusicladium pirinum (Lib.) Fckl.).—Dark, velvety mold patches appear on young fruit and leaves; badly affected fruit drops, but much remains, the dark areas becoming hard and rough and often cracked, deforming the fruit. Plow under all old leaves as thoroughly as possible. Spray with lime-sulfur, 1–12, or bordeaux (formula 13) just as the winter buds first loosen to show the individual flower buds. Repeat just before the first flowers open. Where there is danger of late scab infection, follow directions under "Combined Spraying."

Stigmonose.—A trouble has been noted especially on the Anjou variety, consisting of hard, green, sunken areas. The ripe fruit may be much deformed and worthless. It is supposed to be caused by the piercing of the flesh by some of the larger plant bugs, but the matter has never been studied fully.

Grape Mealybug, Pseudococcus maritimus Ehr. (=P. bakeri Essig).—This mealybug is a small oval, flat insect less than ¼ inch long and covered with white powdery wax and normally with several white, tail-like filaments nearly half as long as the body. The egg sacs look like small masses of cotton. The insects occur under the bark, on the under side of limbs, in cracks, wounds, and in the blossom end of the fruit. Control measures are difficult and consist of repeated applications of crude carbolic-acid distillate emulsion (formula 11) or lubricating-oil emulsions during the winter months and until the buds begin to open in the spring. Scrape the rough bark from the trunks and larger limbs so as to expose the mealybugs to the spray. If the fruit is infested, spray during the summer with water under heavy pressure to wash the bugs away.

Bean Thrips, Heliothrips fasciatus Perg.—Thoroughly dust with the finest grades of dusting sulfur.

Branch and Twig Borer.—See "Apricot," p. 13.

Brown Apricot and other Soft Scales.—See "Apricot," p. 13. Cankerworms.—See p. 77.

Cherry or Pear Slug.—See "Cherry," p. 29.

Codling Moth.—See "Apple," p. 7. The control of this insect on pears is not so difficult as on apples, but thorough work is necessary to insure clean fruit, particularly in districts where large acreages of pears are grown.

Fruit Tree Leaf Roller.—See "Apple," p. 8. Green Apple Aphis.—See "Apple," p. 8.

Italian Pear Scale, Diaspis piricola (Del G.).—A small, gray, circular scale, the body being dark red, usually occurs under the moss or old bark; but it may cover the trunks and all of the main branches of the tree. It causes sunken areas in old limbs and greatly weakens the tree. Spray in the winter months, preferably in January and February, with crude-oil emulsion (formula 22), distillate sprays (formulas 24 and 27), or miscible oils; the crude-oil emulsions are preferable. Thoroughly drench the limbs and trunks.

Pear Leaf Blister Mite, Eriophyes pyri (Pagen.).—A microscopic mite causes pinkish and yellowish blisters or marks on the young terminal leaves and occasionally reddish blotches on the young fruit. Spray in November or February with lime-sulfur 1–10 to kill hibernating mites in buds. November control is particularly recommended for inland and semi-arid regions. If spring control is practical use 4 per cent commercial lime-sulfur (32° Baumé) in the cluster-bud stage or just before the blossoms open.

Pear Root Aphis, Eriosoma languinosa (Hartig).—This is a small dark aphid covered with white cottony material and greatly resembling the woolly apple aphis, but it attacks only the pear roots. For control see "Woolly Apple Aphis," under "Apple," p. 10. Eliminate young stunted trees and replant healthy ones. The Transee root is much more resistant to this pest than the French. Use paradichlorobenzene in the fall (see p. 119).

Pear Thrips, Taeniothrips inconsequens Uzel.—A small, slender black insect ½6 inch long, appears before or at the time the blossom buds begin to open and continues until after blooming season. The young or white thrips work in the late blossoms, but chiefly on the young fruit and leaves. Spray as often as necessary with the government formula (formula 28) or dust repeatedly with 5 per cent or 6 per cent nicotine dust. Watch for adult black thrips as soon as the buds begin to open and apply control measures as soon as any number of the insects appear.

Red-humped Caterpillar.—See "Plum, Prune," p. 63.

San Jose Scale.—See "Apple," p. 9. Treatment for the Italian pear scale above will also suffice for this insect.

## PLUM, PRUNE

Combined Spraying.—For scale, moss, and a general clean-up, spray in winter with crude-oil emulsion (formula 22).

Armillaria Root Rot.—See p. 76.

Black Heart.—See "Apricot," p. 11.

Brown Rot.—See "Apricot," p. 11. Brown rot is not often serious on prunes, but the twig-blight form is sometimes severe in the Imperial variety, and clustered fruit is sometimes completely rotted in various varieties, especially Sugar.

Crown Gall.—See p. 78.

Diamond Canker.—Conspicuous rough diamond-shaped tumors appear on branches and limbs. Cutting out has not proved successful; affected trees slowly decline and the disease spreads slowly in the orchard. Affected trees bear large fruit and orchardists have hesitated to remove them.

Leaf Spot, Coryneum beijerinckii Oud.—See "Apricot," p. 12, and "Almond," p. 4.

Physiological Diseases.—See p. 82.

Plum Pockets, Exoascus pruni Fckl.—This disease is as yet very local. Young fruits puff up early, becoming large and bladdery, then wither and fall. Remove all diseased fruits and twigs and burn. Spray as for leaf curl of peach, p. 53.

Rust, Tranzschelia punctata (Pers.) Arth. (=Puccinia pruni Pers.).—Small, dark brown, powdery dots appear on the lower sides of leaves with corresponding yellow dots above. It has not been observed to be serious.

Sour Sap.—See p. 83.

Unfruitfulness—See also under "Almond," p. 4. The University Division of Pomology is adding constantly to our knowledge of the relations of the varieties for efficiency in cross fertilization. Growers should keep carefully posted on these results. Varieties may be wrongly chosen, bees may be lacking, premature starting and failure of buds may occur.

Wood Decay.—See p. 86.

Almond Mite.—See "Red Spider," under "Almond," p. 4.

Black Scale.—See "Brown Scale," under "Apricot," p. 13.

Brown Apricot Scale.—See "Apricot," p. 13.

Cankerworms.—See p. 77.

Cherry Fruit Sawfly.—See "Cherry," p. 28.

Citrus Red Spider, Paratetranychus citri (McG.), Common Red Spider, Tetranychus telarius Linn., Pacific Mite, T. pacificus, McG., and Two-spotted Mite, T. bimaculatus Harvey.—Small, pale, green or yellow mites, the last with two dark spots on the back, appear in mid and late summer and do great damage to plum and prune trees by causing the leaves to fall prematurely. Dusting and spraying as recommended for the almond mite (see "Red Spider," under "Almond," p. 4) should be done very thoroughly and continued until the first good rains occur in the fall.

Dried Fruit Beetle, Carpophilus hemipterus (Linn.).—This is a small black beetle less than ¼ inch long with a reddish spot near the middle of the dorsum. The adults and small yellowish or whitish larvae feed on the dried fruit and continue to breed indefinitely in storage. They may be controlled in storage by fumigation as recommended for grain weevil (see "Grain," p. 42).

Fruit Tree Leaf Roller.—See "Apple," p. 8.

Indian Meal Moth, Plodia interpunctella Hbn.—The caterpillars are white or pinkish and about 1 inch long. They feed on the dried fruit, through which they work their way to all parts, leaving behind a trail of excrement, webbing, and spoiled fruit. Their presence is usually first indicated by webbing on the fruit or around the sides of the container. The adults are small, slender, silvery gray moths with the apical ends of the wings coppery. This insect is controlled in the same way as the granary weevil (see "Grain," p. 42). Dipping the fruit in scalding water prior to packing kills all forms of this insect. Small packages of dried fruit should be made insect proof to prevent infestation in warehouses and storerooms.

Italian Pear Scale.—See "Pear," p. 60.

Mealy Plum Aphis, Hyalopterus arundinis (Fabr.).—A pale-green aphid covered with a fine white mealy wax collects in great numbers on the under side of the leaves of tender shoots in May and June. Spray with 7 pounds of fish or whale-oil soap to 200 gallons of water, or use nicotine-soap spray (formula 41). The soap alone appears to give as satisfactory results as the nicotine-soap spray and is much cheaper. Summer oil sprays are also very effective.

Pacific Peach Tree Borer.—See "Peach," p. 54.

Peach Twig Borer.—See "Peach," p. 55.

Pear Thrips.—See "Pear," p. 60.

Red-humped Caterpillar, Schizura concinna (A. & S.).—The caterpillars are beautifully lined, reddish, black and yellow with a conspicuous red hump on the back. They feed in large colonies and may entirely defoliate individual limbs or entire trees during the spring and again in the fall of the year. They spin no webs, appear in the fall, and are not to be confused with the tent caterpillars, which appear in the spring. Control measures consist in cutting out and burning the entire colonies when small or in spraying with arsenate of lead as for codling moth, or better, in dusting the infested trees with powdered arsenate of lead thoroughly mixed with equal parts of hydrated lime. The dusting may be effectively done with either a hand or power machine.

San Jose Scale.—See "Apple," p. 9. Tent Caterpillars.—See p. 84.

Tussock Moths.—See "Apple," p. 9.

Western Flat-headed Borer.—See "Apple," p. 9.

#### **POTATO**

Combined Spraying.—Bordeaux mixture will control not only the flea beetles but will materially aid in subduing many fungus diseases.

Black Heart.—Dark clouded areas appear in the flesh and may dry out, leaving cavities. The trouble is due to high temperature or lack of oxygen, or the two combined. It occurs mostly in storage, but may develop before digging.

Brown Streak.—Tubers show a brown ring or streaks in the flesh when cut into. This is apparently due to climatic conditions—high temperature and drought. Affected seed may produce a healthy crop. See "Physiological Diseases," p. 82.

Jelly End, Soft Rot, Leak.—Very soft or watery rots are due to infection in wounds with several fungi, *Pythium*, *Rhizopus*, etc. Avoid injury and bruising in digging.

Mosaic Diseases, Virus Diseases, and Degeneration Diseases.—Several obscure diseases known under the above names have been studied in recent years. Plants show stunted, mottled, crinkled, or with variously abnormal foliage, according to the specific kind of disease. Tubers transmit the same disease. Aphids or other sucking insects spread the diseases in the field. The disease can be controlled only by maintaining a seed plot which is rogued repeatedly, removing all diseased plants at the earliest possible time. Destruction of sucking insects should help to check spreading to previously healthy plants.

Potato Late Blight, Late Rot, Phytophthora infestans (Mont.) De Bary.—Translucent spots appear on the leaves and stems, which spread rapidly till the entire top is wilted and prostrate. The tubers show sunken, somewhat dried surface areas at digging and may rot in storage. Spray with bordeaux mixture (formula 13) immediately after rains.

Rhizoctonia or Black Scurf, Corticium vagum B. & C. (=Rhizoctonia solani Kühn).—Dark, reddish-brown to black scabs are found on the tubers. These may be scraped off, leaving the surface smooth. Underground parts are killed in some cases, destroying plants, reducing the number of tubers, or causing various symptoms in the tops, sometimes with aerial tubers. The fungus is of widespread occurrence in the soil and attacks many plants. See "Wilt," under "Bean," p. 18, "Damping-off," p. 79, etc.

For tuber diseases in general secure seed from healthy fields and reject any tubers showing appreciable amounts of scab, rhizoctonia. wilt (as shown by dark fibers in section of the stem end) or other suspicious symptoms. If scab and rhizoctonia are feared, dip in a solution of mercuric chloride, 4 oz. in 30 gallons of water for 11/2 hours before cutting. This solution should be placed in wooden or earthenware (not metal) containers. The mercuric chloride is injured if dirt, trash, or the sacks come into it. Its strength may be kept up by adding \%-oz. dissolved mercuric chloride for each 4 bushels of seed treated, and water should be added to keep the solution up to the original 30 gallons. If no additional mercuric chloride is added to the solution, the time of treatment may be extended 15 minutes for each treatment and the solution rejected after being used three or four times. Efficiency of the treatment is increased in any case by soaking the seed 12 to 24 hours before treatment. After drying, the potatoes should not be returned to infected sacks. If potatoes are to be sprouted before planting, treatment should be applied to the dormant potatoes. The potatoes should be as clean as possible before dipping. Do not use potatoes treated with mercuric chloride for food.

Hot formaldehyde treatment has been recommended as follows: Soak the seed for 2 minutes in a solution of 2 pints of formaldehyde to 30 gallons of water, kept at a temperature of 118° to 122° Fahr. Place the tubers in piles 6 to 8 inches deep, cover with sacks for 60 minutes and then allow them to dry. Precision with regard to time and temperature is essential and the method has not come into general use.

Potato pathology in recent years has become highly intricate and control measures must be adapted to local conditions. Healthy seed,

rotation of crops, preparation of soil, and management are of great importance. See your farm advisor and authorities on potato culture.

Scab, Actinomyces scabies (Thaxter) Güss. (= Oospora scabies Thax.).—Scab causes the common rough, corky spots in the surface of tubers, which are made unsightly. Underground parts of the growing plant are also injured to some extent. Said to be favored by alkaline soil, or the addition of lime or manure in excess, and retarded by the plowing down of a green cover crop. Use clean seed and dip in a fungicide. See "Rhizoctonia." If only scab is feared, the tubers may be dipped in a solution of formaldehyde, 1 pound (1 pint) to 30 gallons of water for two hours. The solution may be used repeatedly, and is not spoiled by contact with metal.

Wilt and Dry Rot, Fusarium sp., Verticillium sp.—Plants are affected as in severe drought, the leaves ripening prematurely. Tubers appear sound, but often show a ring of darkened fibers when the stem end is cut across. Low temperature in general retards rot associated with wilt. As far as possible, use seed from healthy fields.

**Aphis (Various Species).**—Dust thoroughly with 5 per cent nicotine dust or spray with 1 part of 40 per cent nicotine sulfate to 800 parts of water.

Armyworms and Cutworms.—See p. 76.

Flea Beetles and Leaf Beetles.—See "Melon," p. 48. Use bordeaux mixture (formula 13) as a repellent, or a nicotine-dust—lead-arsenite mixture or 70% sodium fluosilicate dust.

Garden Nematode, or Eelworm.—This microscopic round worm produces a pimply or warty surface on the potato and small brown dots just beneath the skin. Plant only clean seed and avoid infested soil.

Grasshoppers.—See p. 79.

Potato Stalk Borer, Trichobaris trinotata Say.—The larvae are small, pale yellow or white, and not over ½ inch long; they bore throughout the middle of the stalks, causing them to wilt and die. The adults hibernate in the old dry stalks, which should be raked up after digging and burned. This affords an almost perfect control if thoroughly done.

Potato Tuber Moth, Phthorimaea operculella (Zeller).—The full-grown caterpillars are white or pinkish and not over ¾ inch long. They make numerous burrows just under the skin and throughout the tubers, continuing to work as long as the tubers are available. Infestation may occur in the field or in storage. Hill up well around the growing plants and remove the potatoes as soon as dug to prevent infestation in the field. Store in a clean, uninfested place. If infested,

fumigate with 20 to 30 pounds of carbon disulfide to every 1,000 cubic feet of air space at a temperature of 70° Fahr. or over. Plant only clean seed.

Tomato and Tobacco Worms.—See "Tomato," p. 73. Wireworms.—See p. 85.

## ROSE

Combined Spraying.—For fungus diseases and aphids, Black Leaf 40 (nicotine sulfate 40 per cent) may be added to sulfur sprays given for mildew and a sulfur-nicotine dust may also be used for mildew and aphis.

Black Spot, Diplacarpon rosae Wolf. (= Actinonema rosae (Lib.) Fr.,) Black spots about \(^3\)\% inch in diameter appear on the upper surface of mature leaves. The affected spot is not killed at once but gradually turns pale and affected leaves drop prematurely. Clean up fallen leaves and destroy; spray plants and soil below with ammonical solution of copper carbonate (formula 18) while the trouble is serious.

Cold Injury.—Many plants are found in spring with dark-stained leaves or small, distorted, and sickly foliage, owing to chilling of the tender tissue of shoots which start growth too early in winter. Delay pruning until February or later. Prune rather heavily and stimulate vigorous growth by general culture measures.

Mildew, Sphaerotheca pannosa (Wallr.) Lév. and S. humili (D. C.) Burr. (= Oidium).—White, powdery mildew spreads over young stems or leaves, causing distortion or dropping of leaves and discoloration; it is severe in cool coast districts. Spray with lime-sulfur 1–10 before the spring growth starts. Use dry sulfur, sulfur paste, or lime-sulfur 1–35 when disease first appears. Do not water or sprinkle in the evening or on dark days. Good results have been reported in Berkeley from vigorous hosing of plants during the early part of bright warm days.

A recent recommendation is to spray with hyposulfite of soda, 1 oz. in 1 gallon of water, first when leaves are half grown, second when the buds appear and third when color shows in the buds; or in greenhouse use 3/4 oz. per gallon of water and spray every ten days.

This is said not to discolor foliage nor paint if plants are near the house. We do not have information concerning the use of this material under California conditions.

Rust, Phragmidium spp.—Dusty orange-yellow points appear on the leaves; these are the sori or spore masses which break through the surface. In some varieties, especially wild roses, there is swelling and distortion of stems and petioles and the spore masses from yellow become black with large winter spores. Rust is not serious on most cultivated varieties. Control has not been developed but the measures suggested with mildew will probably help.

Aphis (Various Species).—Two common aphis usually infest roses: the large green and pink *Macrosiphum rosae* (Linn.), which commonly attacks the tender tips and buds, and the small green *Myzaphis rosarum* (Walk.), which works on all parts of the plant and produces large quantities of honey dew, resulting in the smutting of the plants. Both may be effectually controlled by dusting liberally with 5 per cent nicotine dust, by spraying with Black Leaf 40, 1 part to 1000 parts of water, or with nicotine soap sprays, or by thoroughly hosing off the plants every two or three days with a strong water pressure and a coarse nozzle.

Fuller's Rose Weevil.—See "Citrus Fruits," p. 33.

Raspberry Horntail.—See "Bush Fruits," p. 24.

Rose Scale.—See "Bush Fruits," p. 25. Spray infested portions of the plants during the winter months with miscible oils.

Rose Snout Beetle, Rhynchites bicolor Fabr.—A small red and black snout beetle, scarcely ¼ inch long, which punctures the buds of roses, causing numerous holes in the petals when the flowers open. Jar beetles into a pan of oil in the early mornings. A 10 per cent nicotine dust has given good control in some places.

#### SNAPDRAGON

Rust, Puccinia antirrhini D. & H.—Brown rust sori break out through the leaf and stem. Infection is usually heavy and the plant becomes unsightly and dies. Water and fertilize freely to stimulate growth. Avoid windy situations and in the greenhouse keep the air as dry as possible. When the disease becomes severe destroy badly affected plants and clean up thoroughly in the fall. Start with clean seedlings. Pentstemon is a fairly good substitute for snapdragon, and does not rust.

Aphis.—Dust thoroughly with 5 per cent nicotine dust.

## SORGHUM, SUDAN GRASS, BROOM CORN, AND MILLET

**Head Smut,** Sphacelotheca reiliana (Kühn) Clint.—The whole head or panicle becomes a black mass. No method of treatment has yet been developed. Affected plants should be destroyed at first appearance. Corn is also affected.

Kernel Smut, Sphacelotheca sorghi (Lk.) Cl.—Kernels form enlarged grains which become fragile and filled with a black powder. It may be controlled by seed treatment. See "Smut" under "Grain," p. 40.

Aphis (Various Species).—See "Grain," p. 41. Armyworms and Cutworms.—See p. 76. Granary and Rice Weevils.—See "Grain," p. 42. Grasshoppers.—See p. 79.

#### SPINACH

**Downy Mildew**, Peronospora effusa (Grev.) Rbh.—Gray-violet areas appear on the lower surfaces of the leaves and plants are considerably injured. Control has not been developed.

Armyworms and Cutworms.—Poison bran mash sown broadcast over the fields has proved very successful in completely protecting young plants. See p. 76.

Beet or Spinach Leaf Miner, Chortophila hyoscyami Panzer.— Small white maggots mine the leaves and cause discolored areas. Keep down all weeds about the fields, burn refuse tops, harvest as early as possible. Winter-grown spinach usually escapes the attacks of this insect.

Flea Beetles.—See "Cucumber," p. 36. Grasshoppers.—See p. 79. Melon Aphis.—See "Melons," p. 48.

SQUASH—See "Melons," p. 47

#### STRAWBERRY

Crown Rot, Botrytis sp.—Disease is prevalent in spring and early summer during periods of damp weather. The bases of the leaf petioles and fruit stalks decay, causing leaves and fruit clusters to die. Normally only the lower leaves and fruit stalks are affected. Keep the surface of the bed as dry as feasible and do not allow irrigation water to come in contact with crowns. The Nich Ohmer variety is very susceptible to this disease.

Dying of Individual Plants (Brown Blight).—In many strawberry plantings, especially in the Los Angeles, Riverside, and Watsonville districts, individual plants dies here and there. At times the dying is confined to spots. The plants usually succumb rather slowly. The lower leaves first turn brown and die; finally the whole plant dies. The conditions above ground are probably the result of injury by some means to the root system.

It is very doubtful if any one specific organism is responsible for the death of all these plants. Various factors, such as drouth, alkali, and poor soil conditions may in some cases weaken the plant to a point where semi-parasitic root invaders may easily gain entrance and continue with the destruction of the roots. At times none of these factors appear to be important. As observed in this state, the Superb, Nich Ohmer, and Mastodon varieties are very susceptible to the disease. Brandywine and Gibson are less susceptible, while Banner and Klondyke are the most resistant of the varieties observed.

The disease is being investigated. At present no recommendations can be made other than giving the plants the best of care and planting the more resistant varieties.

Gray Mold, Botrytis Rot.—See "Fruit Mold" under "Bush Fruits."

**Leaf Spot**, Mycosphaerella fragariae (Schw.) Lind. (=Ramularia tulasnei Sacc.).—Dead spots ¼ inch or less in diameter with red borders occur on leaves; if abundant leaf spot lowers the vitality of the plants. Clean up and burn the leaves in late fall. Spray with bordeaux mixture (formula 13) if the disease becomes serious.

Xanthosis (Yellows, Degeneration).—This is an obscure disease very prevalent and injurious in the central coastal districts. The typical symptoms are a characteristic crinkling and curling, and usually upward cupping of the younger leaves, with a yellowing around the margin and between the larger veins; dwarfing of the leaves, both petioles and blades; and marked stunting of the growth of the entire plant. Affected plants do not die but remain permanently stunted. In summer during periods of continued hot weather the plants may show some recovery, but with the return of cool weather they regain the typical symptoms. Fruit is inferior and often very little is produced. When a mother plant is affected, all the daughter plants still attached show the disease. This disease is of the mosaic or virus type (see p. 63) and is transmitted from diseased to healthy plants by aphis.

Control measures recommended are as follows: Secure healthy, disease-free plants; make new fields or beds as remote as possible from old ones and dip plants in Black Leaf 40, 1–1,000 before planting, to kill any aphids which may be present on them; dust early (see "Strawberry Aphis," below) if aphids appear; also dust any old nearby plantings to prevent migration of aphids; remove all sick plants at the earliest possible moment and destroy, using particular care not to scatter any aphids which may be on them.

New varieties are being tested and many seedlings are being grown in the hope of finding a satisfactory variety which will be more resistant than Banner or Marshall. The Nich Ohmer variety is more resistant but the quality is inferior to that of the Banner.

**Strawberry Aphis**, *Myzus fragaefolii* Ckll.—A very small paleyellow aphis occurs in great numbers on the under sides of the leaves, and often smuts the foliage. Defoliate the plants in winter. Dust liberally with 5 per cent nicotine dust as soon as the aphids appear, applying it to the under side of the leaves with an upturned discharge pipe.

Strawberry Crown Moth, Aegeria rutilans H. Edw.—The white caterpillar, ½ inch long or less, bores into the crown of the plant, causing it to turn yellow and die. Remove and burn infested plants as soon as discovered. Be sure of clean nursery stock.

Strawberry Flea Beetle, *Haltica ignita* Illiger.—A bright metallic, golden, green, or purplish flea beetle, ½ inch long, feeds upon the leaves of the plants. Use bordeaux mixture (formula 13) as a repellent or dust with 70% sodium fluosilicate.

Strawberry Leaf Beetle, Paria canella (Fabr.).—A small brown beetle with black markings on the dorsum and averaging ½ inch long. The adults eat numerous small irregular holes in the leaves, while the small white larvae attack the roots. It is a severe pest, and should be eradicated if possible, by destroying all infested vines and thoroughly sterilizing the soil by steam or carbon disulfide. Established infestations may be reduced by thoroughly spraying with arsenate of lead (formula 2), or by dusting with 1 part of basic powdered arsenate of lead to 4 parts of powdered hydrated lime.

Two-spotted Mite, Tetranychus bimaculatus Harvey.— See "Bean," p. 19, and "Prune," p. 62. Though this mite is ordinarily controlled with dry sulfur, this method cannot be used on strawberries because of the severe burning to the foliage. Very small amounts of sulfur in the ditches between the rows have afforded some relief. Highly refined white lubricating-oil emulsions have given good control without injury.

### SWEET POTATO

Black Rot, Sphaeronema fimbriatum (E. & H.) Sacc. (= Ceratocystis fimbriata Ell. & Hals.).—Black spots appear on sprouts and circular black spots on surface of potatoes, with tissue below greenish. Affected potatoes are bitter when cooked. The rot spreads in storage. See "Wilt."

Foot Rot, *Plenodomus destruens* Harter.—Brown to black spots appear on stems near surface of soil late in season and plants finally wilt, usually not producing potatoes. Foot rot also causes a brown firm rot of potatoes often starting in wounds. See "Wilt."

**Scurf,** *Monilochaetes infuscans* E. & H.—A brown discoloration or spotting occurs on the surface of the potatoes rendering them less attractive and more liable to dry out in storage. See "Wilt."

**Soft Rot,** Rhizopus nigricans Ehr.—This rot is mainly a storage trouble; rot starts at injuries and progresses rapidly; the decayed part becomes covered with white mold, which later turns black. Avoid bruising. Dry well before storing. For long keeping, pack in dry sand. Moisture and temperature requirements of sweet potatoes in storage are different from those of most other products and must be carefully observed.

Wilt or Stem Rot, Fusarium sp.—Leaves become paler than normal; plants wilt and die; stems have the fibers blackened and this shows also in the stem end of the potato as a blackening when cut across.

Stem and root diseases of sweet potatoes require similar treatment. Hotbeds which have been used previously for sweet potatoes should be cleaned out and soaked with formalin 1 pound to 30 gallons of water. The soil used should be from some place where sweet potatoes have never been grown or should be disinfected (see p. 126). The manure should have no remains of sweet potatoes in it. Plants and potatoes are both subject to infection. Where wilt is present, select seed potatoes in the field before frost, cutting across the stems and rejecting all hills which show black rings. Store all seed potatoes separate from the main crop, where contamination may not spread to them. Where diseases are serious, dip the seed in mercuric chloride as for white potatoes (see p. 117), except that the time of soaking must not exceed 5 to 10 minutes. Where diseases become troublesome, rotate crops, planting no sweet potatoes for three to six years.

TOBACCO—See "Tomato Worm," p. 73

## TOMATO—See also "Potato"

**Blossom End Rot.**—Dry spot appears at blossom end of green fruit and develops slowly. Avoid drought or irregular irrigation.

Damping-off.—See p. 79.

Fruit Decays.—In California fruit decay is due mostly to common molds which gain access in some mechanical injury and develop on the way to market. Remove all refuse fruit to a safe distance from the packing house. Avoid mechanical injuries in the fruit.

Late Blight, Late Rot, Phytophthora infestans (Mont.) De B.—In late moist weather large vague spots appear on the leaves, at first dark and watery, becoming slightly frosted with emerging fungus threads below, then deteriorating rapidly. Similar spots appear on the fruit, not well marked at first, but the fruit spoils rapidly. Spray with bordeaux mixture (formula 13) immediately after rains.

Tomato Yellows (Western Yellow Blight).—Leaves of the affected plants roll upward, exposing purplish veins underneath, and are thicker and stiffer than leaves of normal plants. The growth is checked and the whole plant turns rigid and takes on a sulfur-yellow color. Whatever fruit is formed reddens, but does not increase in size. Under moderate climatic conditions the diseased plant may live a long time, but the complete recovery is very rare.

The disease is due to the same virus (see "Virus Diseases," p. 84) that causes curly top of sugar beets and is likewise carried from plant to plant by the beet leafhopper. Many wild and cultivated plants are hosts for this virus, which makes the control of this disease extremely difficult. No resistant commercial variety of tomatoes is as yet available.

The valuable early crop may be protected to a considerable degree by shading, since the insects avoid shady places, and furthermore the plant is able to withstand the infection in the shade better than in the open. The shading material may be removed toward the end of June. The danger of new infection on and after that time appears to be much lessened, first because the main spring flight of the insects is then over, and second because older plants are less susceptible to the infection. Late plantings, also, as a rule, have a small percentage of yellows.

Wilt, Fusarium lycopersici Sacc. and Verticillium sp.—Affected plants may wilt, or leaves curl downward, beginning with the lower ones, turn yellow, then brown, and die. The effect is a somewhat gradual one and only part of a plant may be affected. If the affected

stem is cut across, the woody parts show more or less darkening, especially in later stages. Most affected plants dry up and die. It is caused by soil-inhabiting fungi which gain entrance to the roots. It may be held in check by rotation of crops and proper precautions as to the seedbed. Resistant varieties are available, notable among which is the Norton, a selection from Stone and with similar qualities. See "Tomato Yellows," above.

Armyworms and Cutworms.—See p. 76.

Darkling Ground Beetles, Blapstinus sp. and Metoponium abnorme (Lec.).—Small, dull-black or bluish-black beetles, scarcely more than ¼ inch long, living in the soil and responsible for much damage to young plants shortly after transplanting. Before resetting, wrap the stems of the young plants from roots to tops with tissue paper so as to have three or four thicknesses for protection, or scatter poison bran mash (formula 5) over the ground at planting time.

Flea Beetles.—Dust with powdered arsenate of lead, 1 part to 4 parts of dry lime, or sulfur-nicotine dust and arsenate of lead (or 70% sodium fluosilicate dust, or spray with bordeaux mixture (formula 13).

Garden Nematode.—See p. 82.

Grasshoppers.—See p. 79.

Tomato Worm, Protoparce sexta Joh. and Tobacco Worm, P. quinquemaculata Haw.—These large green worms, often attaining a length of 4 inches, strip the leaves from the vines. The adults are known as humming-bird moths because of their large size and swift flight. They are gray with yellow spots on the sides of the body and have a wing expanse of 4 or 5 inches. The caterpillars may be controlled by hand picking, i.e., cutting the worms in two with a pair of seissors, or by dusting the vines with 1 part of powdered arsenate of lead to 4 parts of finely ground hydrated lime.

#### WALNUT

Armillaria Root Rot.—See p. 76.

Blight, Pseudomonas juglandis Pierce.—Young tender parts are attacked. Spots at first watery, soon turning black, often spread and kill young nuts, leaves, or tender tips of shoots. No specific remedy is known. Give the trees the best possible care. Thin out the tops of the old trees. Control aphis. Plant resistant varieties.

Crown Gall.—See p. 78.

**Crown Rot,** Phytophthora cactorum (Leb. & Cohn) Schroet.—This disease attacks the crown and adjacent portions of the roots of the southern California black walnut (Juglans californica) when used as a rootstock for the English walnut. The northern California species (J. hindsii) is apparently less affected and the English walnut very resistant under field conditions. In advanced stages of the disease the crown lesions frequently extend well upon the trunk of the budded English variety, from which the organism is easily isolated. The lesion on the crown is characterized by a soft, dark brown to black, frequently watery, and spongy condition of the bark below the bud union.

When cases of the disease are detected in a grove on black-walnut stock an examination of the crowns of all trees is advised. Infected areas should be removed, the wounds painted with bordeaux paste (formula 14) or some other fungicide, and the crown left exposed to the air for some time.

Melaxuma, Dothiorella gregaria Sacc.—Black sunken cankers develop on larger limbs and trunks; the limb may be girdled and the part above die. Cut out diseased bark areas and apply bordeaux paste (formula 14).

Moldy Nuts.—Kernels become moldy and are unsightly, resulting in reduction in market value, or perhaps the whole crop must be sold at a lower price. Trouble begins on the tree, mainly in stick-tights and nuts with injuries of various sorts in the husk, and increases rapidly if the nuts remain on the ground for a considerable time. It is caused by common molds, the principal one being an Alternaria, which grow in the husk and penetrate into the cavity of the nut. Give the trees the best possible care to avoid sunburn and similar injuries to nuts. Proper soil moisture is important. Harvest and cure as promptly as possible, keep all stick-tights or otherwise defective nuts separate from the beginning, so as not to mix them with the better nuts and depress the grade of the whole crop.

Winter Killing.—Irrigate about November 1, if no good rains have fallen. Whitewash trunks in the fall. Do not irrigate after August, except as above.

Codling Moth, Carpocapsa pomonella (Linn.)—See "Apple," p. 7. This worm sometimes feeds on the green husks but usually bores directly into the kernel of the walnuts before they are mature, and also often works its way into the kernel after the shell becomes hardened by making an entrance in the suture at the base. It may be controlled by spraying with basic arsenate of lead or by dusting with

powdered basic arsenate of lead and hydrated lime when work on husks of nuts is first observed in the spring—May, June, or July—depending upon climatic conditions due to location near the coast or inland. Consult local horticultural officials.

Frosted Scale, Lecanium pruinosum Coq., and Cherry or Calico Scale, L. cerasorum Ckll.—Use same control as for brown apricot scale; see "Apricot," p. 11.

Indian Meal Moth.—This moth attacks walnuts in storage. See "Plum, Prune," p. 62.

Nautical Borer, Xylotrechus nauticus Mann.—The borers are small, fleshy, white or yellowish grubs, with slightly enlarged anterior end and about ¾ inch long. The adult beetles are ½ inch long, dark with narrow broken yellow or whitish cross-bands on the elytra. The larvae work in the small twigs, limbs, and trunks of both healthy and sickly trees. Cut out and burn all infested portions. Destroy all dead oaks or prunings in the neighborhood to eliminate breeding places.

Red-humped Caterpillar.—See "Plum, Prune," p. 63.

Two-spotted Mite.—See "Citrus Red Spider, etc.," under "Plum, Prune," p. 62. Dust thoroughly with dry sulfur.

Walnut Aphis, Chromaphis juglandicola (Kalt.).—A small pale-yellow aphis occurs in great numbers on the under sides of the leaves and produces great quantities of honeydew, which causes severe smutting of the foliage. (See "Mealybugs," p. 80.) Dust thoroughly with a 2 per cent nicotine dust during last week of May or the first part of June. Sometimes a second application is necessary in July or August.

Walnut Blister Mite, Eriophyes tristriatus (Nalepa) var. erinea (Nalepa).—A microscopic mite producing yellow or brown felt-like galls on the under sides of the leaves. It is not a serious pest, but may be cleaned up by spraying trees with lime-sulfur 1–10 in the spring when the buds are swelling. Control measures are not recommended except in extreme cases.

Yellow-necked Caterpillar, Datana ministra Drury.—A black, hairy caterpillar with numerous longitudinal yellow stripes on the back and sides and a yellow or orange-colored neck. It averages about 2 inches in length and is closely related and similar in habits to the red-humped caterpillar, and may be handled in the same way. See "Plum, Prune," p. 63.

WATERMELON—See "Melons," p. 47 WHEAT—See "Grain," p. 40

## GENERAL SUBJECTS

# ARMILLARIA ROOT ROT (OAK FUNGUS), Armillaria mellea (Vahl) Quel.

Armillaria root rot is caused by a native fungus which lives saprophytically and parasitically in roots of woody plants. Trees and bushes are killed in spots, which enlarge year after year. Affected trees fail gradually from the diseased side or die suddenly in summer. Under the affected bark of roots there is a yellowish-white fan-shaped mycelium, which progresses into the live bark. Black or brown shining root-like strings (rhizomorphs) grow out from old rotting roots. The wood decays with a uniform white rot. Large tan-brown toadstools (edible when cooked) arise from old infections, October to February.

Surgery may be practiced on roots and crowns of trees not too far gone. It is usually necessary to examine the first row of healthy trees beyond the affected ones to be certain the fungus is not creeping up on the main roots and crown. All dead bark and roots should be carefully removed and destroyed and if possible the roots should be left exposed for some time. Drying is effective in killing out the fungus. Painting roots with bordeaux (formula 14) or other fungicide is helpful before replacing soil around roots. Treated trees should be examined the following year for signs of reoccurrence.

True northern California black walnut, French pear, and fig roots are highly resistant. Annual fibrous-rooted plants are rarely injured. Affected areas in orchards may be isolated by opening a trench 4 to 5 feet deep and 18 inches to 2 feet wide around them. This may be filled immediately if reopened every two years to keep the roots cut off. A nursery should not be planted in infected soil.

## ARMYWORMS AND CUTWORMS

General Life History.—The adult members of this family (Noctuidae) are practically all night-flyers. The caterpillars of many are known as armyworms and cutworms and are among the most destructive of insect pests. They often advance from field to field in great numbers, like an army, devastating as they go. Like the grasshoppers, they attack practically all kinds of plants, including field and truck crops, vineyards and orchards, flowers and weeds.

The adults lay their eggs in spring and the larvae become exceedingly numerous in early summer, when most of the damage is done.

The pupal stage is passed under ground, the light or dark-brown naked chrysalids being housed in small earthen cells. There are several broods a year. The winter is usually spent in the pupal stage, but some larvae and adults hibernate. A hibernating larva often seriously injures grapevines in the spring by eating the buds.

Control.—The control of these insects has been a difficult problem for years, and even today the methods worked out do not always give relief.

Clean culture in fall and thorough plowing of infested fields to kill the hibernating pupae in the cells is supposed to greatly reduce the next year's broods. This has been recommended as especially important in pea fields and gardens.

When the worms begin to march, trenches may be plowed across and ahead of their paths with a perpendicular wall in front of the advance. The worms, not being able to cross, will gather in great masses in these trenches and can be easily killed by spraying with crude oil or by crushing them with a narrow disk or roller.

Arsenical sprays applied as soon as the larvae begin to appear will sometimes materially aid in protecting crops like potatoes, tomatoes, young trees, grapevines, but are seldom practical for forage crops.

Poisoned baits (formulas 5 and 6) sown in the infested fields will kill countless worms, and these afford by far the most satisfactory means of killing these insects under all conditions. In fields, pastures, orchards, and gardens, the poisoned baits may be freely sown over the plants. The armyworms and cutworms will eat the bait in preference to growing vegetation.

Light traps are also used to capture the adults, but these have never seemed to greatly lessen the attacks, because large numbers of the moths captured have previously laid their eggs.

Natural Enemies.—By far the most important factors in the control of armyworms and cutworms are natural enemies. The parasitic tachinid flies kill countless numbers of them. Hymenopterous parasites of the family Ichneumonidae also prey upon the young. The predaceous ground beetles of the family Carabidae devour the worms and destroy great numbers. That armyworms and cutworms are not injurious every year is undoubtedly because of the work of these natural enemies.

## CANKERWORMS

Cankerworms are small green or dark measuring worms less than an inch long, which feed upon the leaves and young fruit and drop down on a silken thread when the tree is jarred. The females are wingless and crawl up the trees in the fall or spring to lay their eggs on the limbs and small branches.

Egg laying on the trees is prevented by placing tanglefoot, cotton, or permanent wire screen bands around the trunks of the trees in the fall in order to catch both the fall and spring worms. The caterpillars are easily jarred from the trees, but will crawl up again if not obstructed. Spraying with arsenate of lead (formulas 1 or 2) will also give control. Pyrethrum or buhach powder,  $2\frac{1}{2}$  to 5 pounds soaked overnight in 5 gallons of cold water and then enough water added to make 200 gallons of spray, has given remarkable results in the control of the cankerworms.

## CROWN GALL, Bacterium tumefaciens S. & T.

Rounded fleshy to woody tumors form on roots or sometimes on above-ground parts, usually starting from wounds, persisting and growing at the edges from year to year, often girdling or causing the tree to break off.

For nurseries, avoid old vineyard, orchard, or berry land which has been seriously infected. Throw out all affected nursery trees. The clean trees in a lot in which a large percentage are affected are of doubtful value.

In orchards, occasionally examine crown and main roots, especially of stunted trees. When not too far advanced this disease may be controlled by chiseling out the galls, removing all abnormal tissue to healthy bark and down to sound wood, sterilizing with mercuric chloride (formula 20 or 21), and covering the wounds with bordeaux paste (formula 14) or asphaltum. The trees must be gone over again after vigorous growth has been going on for several weeks and the new galls which arise at the wound margins treated. Reinspection is essential. Badly affected and stunted trees should be pulled out and replanted, using fresh soil.

Recent studies in Wisconsin with apple bench grafts show that a badly fitting scion may develop at the lower end a conspicuous enlargement or hairy root which is not true crown gall. This is prevented by securing a smooth fit and close wrapping of the lower end of the scion.

Dipping bench grafts in the organic mercury compounds (see p. 117) is said by M. B. Waite<sup>7</sup> to have reduced the number of galls; this will probably be useful with nursery stock, but the practical application has not been worked out.

<sup>&</sup>lt;sup>7</sup> Waite, M. B., and E. A. Siegler. A method for the control of crown gall in nursery. U. S. Dept. Agr. Circ. 376:1-8. 1926.

## DAMPING-OFF

Young seedlings rot at or below the surface of the ground and fall over or wilt. Many may die before emerging. Damping-off is caused by various soil fungi, *Pythium*, *Rhizoctonia*, *Fusarium*, and others. It is best controlled by skill in watering. Water the plant beds only in the morning and on bright days. Do not sprinkle oftener than necessary. In greenhouses or frames give plenty of ventilation. In making citrus seed beds put an inch or two of dry sand on the top of the soil. Some forms of damping-off may be prevented by soil disinfection (see p. 126). Where damping-off has started, spraying the plants and ground with bordeaux or organic mercury compounds (see p. 117) may do some good.

## FROST AND COLD INJURY

With young citrus trees in frosty localities, wrap the trunks with corn or mile stalks in winter. Heap up earth around the bases, since cold injury is liable to be most severe near the surface of the ground. Enclose tender valuable young trees with burlap covers. For bearing groves obtain detailed information about methods and appliances for smudging with oil fuel. Many plants are injured and disfigured by cold at critical stages of development, even when it is not cold enough to kill or even noticeably injure them at the time. See also "Sour Sap," p. 83.

## GRASSHOPPERS

Scatter poison bran mash or citrus bran mash freely (formula 5 or 6). Be sure to mix the bran and poison thoroughly. Scatter in alfalfa fields about 4 o'clock in the afternoon and around orchard trees or other plants early in the morning.

## **GUMMOSIS**

Gum formation in itself is not due to any one specific disease, but may be brought about by many different causes. In stone fruit and citrus trees gumming is simply a symptom of distress, which may be due to specific infections or various other causes, such as unsuitable soil, poor condition of soil, sunscald, excess or lack of water, frost, or attacks of parasites. Treatment must vary according to cause. Badly gummed branches may be removed, gummy diseased areas of bark cut out, and the wounds treated as in citrus gummosis. Splitting

the bark is useless and often harmful. For gummosis due to parasites see "Bacterial Gummosis" under "Apricots," p. 10, and "Gummosis" under "Citrus Fruits," p. 32.

# MEALYBUGS, Pseudococcus spp.

In California mealybugs are among the most serious enemies of many of our native and introduced plants, particularly subtropical fruits and ornamental flowering plants and shrubs. They infest all parts of the plants, including the roots, branches, leaves, flowers, and fruits, and often collect in compact colonies and deposit their eggs in masses of cotton-like waxy material which are most evident in late summer, fall, and winter.

The newly hatched insects are very minute and just visible to the naked eye. They are yellowish and as they grow they become covered with a whitish, powdery wax which extends as short rods around the margins of the body, and as longer filaments or tails posteriorly. The shape and length of these posterior filaments are useful in distinguishing the various species. The white waxy covering is responsible for the common name, mealybug. The males are minute two-winged insects which are often seen hovering about the infested plants during the late afternoons and evenings in the fall of the year.

Mealybugs, like many other scale insects and like aphis, excrete quantities of honeydew which covers the infested plants like a thin coating of syrup. In cool and temperate areas, such as the coastal region of this state, a black-smut fungus grows on the honeydew, which is responsible for the dirty, smutty appearance of plants infested with these insects. To eliminate the smut it is necessary to get rid of the mealybugs or other insects which produce the honeydew. Ants are fond of this sweet excrement and protect the mealybugs to insure a constant supply of it. Therefore, in connection with mealybug control it is always advisable to control the ants as well, using the poisons as recommended on pages 110–111 (formulas 8 and 9).

Mealybugs are difficult of control, owing to the protection afforded by the white waxy covering and their habits of collecting in dense colonies, depositing their eggs in large cottony masses, and feeding also underground. In the citrus orchards of southern California and in the vineyards of some parts of the Sacramento and San Joaquin valleys, ladybird beetles and minute parasites are reared and liberated at a considerable cost to the growers, but with much effectiveness. In the San Francisco Bay region, however, it is too cool in most sections for these natural enemies so that it is necessary to resort to sprays. A spray program recommended for mealybugs is given below.

Spring and Summer Control.—Thoroughly hose off the infested plants with a nozzle and as strong water pressure as is available. Hosing alone will sometimes control mealybugs. Spray shortly afterwards with any of the highly refined so-called summer oil sprays at a dilution of from 4 to 6 per cent or as indicated by the manufacturer. These sprays are all made under secret process and patent and can be procured at a reasonable price from insecticide dealers and florists. Use as much force as possible and a coarse driving spray. Repeat applications of sprays every week until satisfactory control is obtained. Two or three applications may be necessary. Remove soil about roots and pour in a quantity of the diluted spray to kill mealybugs on the roots.

Water infested plants a day or so before spraying them, because plants suffering for want of irrigation are very susceptible to spray injuries, especially when oil emulsions are used.

Soap and nicotine sprays are of little value unless used in combination with oils. Homemade mixtures are likely to injure tender plants.

Winter Applications.—Dormant deciduous plants may be sprayed with any of the homemade oil sprays recommended in this bulletin or with miscible or other manufactured oil sprays. Evergreen plants may be sprayed during the winter with the summer oils or more highly refined miscible oils and other oil emulsions. Homemade mixtures may also be used on the hardier plants. In other respects, conform to the recommendations given above.

# NEMATODES (EELWORMS)

Microscopic worms of several species penetrate the tender tissues of plants.

Soil intended for greenhouse use should be taken from places where nematodes do not occur. The absence of nematodes is best determined by examining growing plants such as figs, peaches, melons, tomatoes, or nearly any soft-rooted vegetable. If it is not possible to get soil which is certainly free, it should be disinfected (see p. 126). Nematodes are worse on sandy soils. They are frequently distributed in potatoes and rooted plants.

Beet Nematode, Heterodera schachtii Schmidt.—This nematode attacks beets and a few other plants, and where it occurs careful rotations should be followed with total exclusion of beets for many years. Alfalfa may be safely planted on beet-nematode soil.

Garden Nematode, Caconema radicicola (Greef) Cobb.—This nematode causes rounded irregular fleshy swellings or root knots on tender roots. If abundant, the roots may become much distorted and swollen, growth stops, and early rotting-off follows.

Do not attempt to grow susceptible crops on infested soil. Keep such areas clean-cultivated in summer or in a cereal crop. Grain may be grown in winter. Almost all important crops, except cereals and some fruit trees, are attacked by this nematode. Alfalfa is not seriously affected but carries it over to future crops.

Stem Nematode, Tylenchus dipsaci Kühn.—Stem nematode has recently attracted attention in various parts of the United States. It attacks many plants such as strawberries, alfalfa, clover, bulbs, grains and many plants in the above ground parts (see "Alfalfa," p. 3 and "Bulbs," p. 21).

## PHYSIOLOGICAL DISEASES

# (Little Leaf, Exanthema, Die-Back, Mottled Leaf, Rosette, Bitter Pit, Dry Rot, Black Measles, Blossom-end Rot)

Physiological diseases are diseases of a specific nature, the cause of which is not known and the symptoms of which seem unlike the usual effects of unfavorable conditions or parasites. Most of these troubles show a relation to soil conditions and occur especially in dry. sandy, gravelly, or hardpan soils, those very deficient in humus, or under conditions of irregular soil moisture. Trees standing over old barnvards or corrals or where excessive amounts of manure have been applied are also likely to show some of these troubles. promising methods of treatment are increasing the humus content of the soil by means of green-manure crops and mulches, breaking up all hardpan and plow-soles, more careful irrigation to insure the maintenance of a proper and uniform moisture condition of the soil down to a depth of several feet and throughout the season until rains occur, and planting alfalfa in orchards where plenty of water is available. soil in areas where these troubles occur should be examined for alkali or other injurious substances. Where any of these diseases are serious and persistent it may be better to grow some other crop than to keep on with one which is seriously affected.

## SLUGS AND SNAILS

Slugs and snails may be controlled to some extent by thoroughly dusting finely powdered hydrated lime over the infested plants, but recent investigations have shown that a 5 per cent nicotine dust is very effective in killing these pests if applied late in the evening or on dull

days when the animals are at work on the plants. Trapping by means of boards or wet sacks and killing those taking shelter under them is effective in a small way. Liberal applications of dry bordeaux mixture as a dust on the ground and infested plants acts as effective repellent. Also use formula 5.

# SOUR SAP, WINTER INJURY—See "Sunburn," p. 84

All the ordinary forms of sour sap are associated with extreme variations in temperature. Differences in the effect upon individual trees or orchards are due to differences in condition and susceptibility of the trees, produced mostly by variation in the moisture condition of the soil. Do not force growth late in summer. Irrigate, if possible, about November 1, if no heavy rain has fallen. Whitewash bodies of trees early in November.

Sour sap seems to be associated with hardpan or periods of surplus water in the soil. Good drainage should be emphasized. A furrow may be opened in early winter on either side of the tree row to carry off surplus winter rains and prevent the soil from remaining saturated for prolonged winter periods. Numerous instances have been observed where open irrigation ditches drained adjacent tree rows during the winter; trees in the drained soil escaped sour sap while those farther from the ditch in soil saturated with winter water have suffered badly. A number of distinct injuries have doubtless been referred to under the above names. Some may be due to specific bacterial infections.

## SOWBUGS

Sowbugs are attracted to sweetened baits and are readily controlled by the use of a poisoned mash (also see formula 5), made by mixing together, dry, 1 pound of wheat bran and 1 ounce of paris green which are then sweetened and moistened to the consistency of a mash by using 2 tablespoonfuls of blackstrap molasses diluted in 1 pint of water. This bait is sown broadcast throughout the garden or placed in small portions under boards or inverted flower pots filled with straw where the sowbugs collect. It may also be used in greenhouses, but what appears to be more satisfactory under glass is a poison composed of five parts of granulated or brown sugar and one part of paris green mixed dry and placed on small wooden or tin plates throughout the beds, or poured on the frames of the beds of the greenhouse. This bait can be used outside also if protected from the rains and excessive soil moisture. It is, perhaps, wise to offer a word of caution regarding the use of the bran bait where poultry may

pick it up and the use of the sugar and paris green in places frequented by children.

#### SUNBURN

Whitewash bodies of the trees in fall as well as spring. Shape the trees so that their trunks are shaded. Cut young trees back well before planting. Shade trunks with shakes or protectors. Do not allow trees to suffer from drought.

Tests show that the coloring matter in the bark of the trunk and exposed main limbs absorbs heat enough on sunny days in winter to raise the temperature of the growing layer 35° to 40° Fahr. above the temperature of the air. As soon as the sun goes down the tree cools rapidly to atmospheric temperature, which may be freezing or below. Whitewash reflects the heat, so that the growing layer does not get warmer than the air; the cells remain dormant during the day, and are not injured by low temperatures at night. Whitewash will also help to prevent sour sap.

## TENT CATERPILLARS

The gray or brown, hairy caterpillars have a row of white spots on the back or pale bluish lines on sides and measure from 1 to 3 inches long. They live either in compact colonies or in tightly woven webs or tents which are conspicuous on the trees. Entire colonies may be exterminated by cutting off or burning with a torch or by dusting infested portions with powdered basic arsenate of lead. Those on the trunks and large limbs may be killed by spraying with kerosene or concentrated oil emulsions. The small dark egg masses encircling the smaller limbs may be pruned out when the trees are dormant and burned. Spraying with arsenate of lead (formula 1 or 2) will control the caterpillars effectually.

## VIRUS DISEASES

A virus disease may be defined as an infectious disease caused by a filtrable virus. A filtrable virus may in turn be defined as a disease-causing agent which is so small that it readily passes through filters which prevent the passage of known disease-producing bacteria. The filtrable viruses are so small that man has never been able to see them by the use of his finest microscopes.

The filtrable viruses, which are more commonly called simply 'viruses,' are usually spread from diseased plants to healthy plants by insects of various kinds. The viruses may in certain cases be carried through the winter in cold-resisting weeds and may then be spread to cultivated plants by insects during the warmer seasons of the year.

Certain of the virus diseases, such as the mosaic diseases of beans and lettuce, are said to be carried over in the seed.

The symptoms of the different virus diseases vary considerably. Stunting is evident in practically all of these diseases if the plants are infected while young. In the mosaic diseases the leaves are distinctly mottled. This mottling or mosaic appearance is particularly evident in the young upper leaves. There may also be considerable distortion of various parts of certain virus-infected plants. A good example of this is seen in mosaic tomatoes where the leaves may grow out into the so-called 'shoestrings,' and in the stalks of yellows-infected celery plants which become twisted and malformed. In other diseases, such as curly top of the sugar beet, the veins in the younger leaves have a transparent appearance.

The control of virus diseases has in general been rather unsuccessful. Spraying or dusting to kill the virus-transmitting insects and the elimination of overwintering weeds are steps which may aid in preventing the spread of certain virus diseases.

In the case of potatoes the use of disease-free tubers for planting should be practiced.

## WIREWORMS

Wireworms get their name from their smooth, round bodies, which are usually shiny, varying in color from pale-yellow to dark brown. The common injurious forms are about 1 inch long. They live in the soil, preferring sandy loams rather than heavy soils, although they may be found in either. The larval stages last from 1 to 3 years, so that to be effective, control measures must cover the maximum period. The adult beetles are known as 'click beetles' because of their ability to jump in the air with a clicking sound. They are mostly inconspicuous beetles of various shades of brown or entirely black, about ½ inch long. They are active and fly freely.

Control measures are difficult because of the underground habits of the larvae, and as yet have not been satisfactorily worked out for the different species. Clean culture and crop rotations are the most reliable practices, and much good comes from thorough cultivation. Trapping the adults with small piles of straw and burning them in fall and winter destroys large numbers. Replanting is often necessary with many crops such as potatoes, beans, peas, and melons. Some control is claimed from scattering poison bran mash (formula 5) over the surface of the ground. A teaspoonful of paradichlorobenzene in the soil near dahlia or potato tubers and bulbs has given very good protection but if it is used excessively burning and injury results.

## WOOD DECAY (Treatment of Pruning Cuts and Wounds)

It is doubtful whether any application on wounds materially assists healing except for some delicate plants like roses, where the cut stem may dry out. Treatment is to prevent infection with spores of wood-decay fungi, which may be carried by wind or rain, or otherwise, and be protected in cracks or rough places in dry wood or bark until moist weather, when they grow and penetrate the wood, causing rot. At some seasons bark knocked off may be renewed over the whole surface if undisturbed, or the bark may be replaced and held firmly and again grow on. Usually a wound must heal from the edges.

The greatest danger comes from cracks in the heartwood, from rough breaks and from the 'heel' at the bottom of a bad cut in which the bark nearly always dies back. Proper training of trees from the beginning to avoid narrow pinching joints and subsequent splitting is important.

Treatment should be prompt, since when decay is established no disinfectant can be expected to penetrate far enough to destroy the active fungus in the wood. Make a clean cut, trimming the bark down smoothly to sound tissues around the edges. In the case of branches. make a close cut, leaving no projecting stub. Thoroughly cover the wound with bordeaux paste (formula 14), and when well dried cover with grade D asphaltum put on in a melted condition. Go over the work occasionally, especially in summer or early fall, and renew the application of asphaltum until the wound is entirely healed. Bordeaux mixture may retard the formation of callus. Some prefer to paint the whole wound at once with hot asphaltum. Others prefer to use the asphalt paint cold, but this should be done with care to keep cracks in the wood thoroughly covered. Some asphaltums, especially the cold paints, have caused injury. A proprietary compound known as asphaltum emulsion mixes with water and may be used on wet surfaces. Bordeaux in dry powder mixed with crude (not boiled) linseed oil to make a paint has been recommended. Copper nails driven close together in large wounds and copper screen over the surface painted with bordeaux paste should be useful in preventing decay. Where wounds have stood for some time before covering, it would be well to wet the dry wood with a solution of mercuric chloride, 1 part in 500 parts of 50 per cent alcohol (1/4 ounce in 1 gallon). See p. 117 for precautions in using mercuric chloride.

For tree surgery methods, send to Superintendent of Documents, Washington, D. C., for Farmers' Bulletin No. 1178, price, 5 cents.

## RODENT PESTS

## GROUND SQUIRRELS

The five most effective methods of destroying ground squirrels are: (1) poisoning with strychnine-coated grain; (2) fumigation with carbon disulfide; (3) trapping; (4) shooting; (5) encouragement of the natural enemies of the ground squirrel. (See Exp. Sta. Cir. 296.)

- 1. Carbon disulfide is most effective when the soil is damp. When the ground is dry the gas escapes through the cracks in the ground. (See "Carbon Disulfide," p. 111.)
- 2. Strychnine-coated barley (formula 33) is best used during the dry season because at this time the squirrels gather and store grain and hence are easily poisoned through their cheek pouches when in the act of carrying the poisoned grain. Rain and heavy fogs tend to wash the strychnine off the poisoned grain. The poisoning is best done in the early part of the dry season because many of the old squirrels aestivate in late summer and fall. The grain should be put out in small piles only in the months of burrows and on hard ground in squirrel paths; not broadcasted so that beneficial animals and birds will be killed and the grain wasted.
- 3. Trapping and shooting are effective at any time, but are from six to twelve times more so before the young are out, before April 1, than later in the season.
- 4. Powdered strychnine (sulfate) in fresh vegetables and fruit is especially effective in the dry season when green food is scarce (formula 33).
- 5. Red-tailed hawks, Golden eagles, badgers, weasels, and other natural enemies of the ground squirrel will prove valuable allies in the war on ground squirrels if they are only allowed to live. It costs little to let them alone to go about their business in the natural way.

## **GOPHERS**

The five most effective methods of destroying gophers are: (1) poisoning with strychnine; (2) trapping; (3) flooding; (4) fumigation with carbon disulfide; (5) for permanent relief, the encouragement and protection of the gopher's natural enemies, especially the

barn owl and the gopher snake. The solution of the gopher problem lies in a combination of two or more of the above methods, rather than in any one of them.

Where a large acreage is to be treated, poisoning with strychnine (formula 34) will be found most effective in reducing the pest.

Traps are *safe*, can be used at any time, and are effective in the hands of a man who is not afraid to dig and who uses care in setting and placing them. Trapping is especially adapted to pastures, where there might be danger of poisoning stock, and to gardens, orchards, and the banks of irrigation ditches where individual gophers are causing the damage.

Carbon disulfide should be used only when the ground is wet. Both traps and carbon disulfide are good follow-up methods in getting the gophers which refused to take poisoned bait.

Land that can be successfully flooded, so as to drown out the gophers, has usually been graded for irrigation crops such as alfalfa. Flooding (irrigation) is therefore automatic, and it is comparatively easy to hunt and kill gophers which are being flooded out. Thereafter the margins of the field should be watched to keep out new invaders. A man who kills all the gopher snakes and barn owls on his place will have to fight gophers and deservedly so. (See Ext. Cir. 29; also Exp. Sta. Cir. 273.)

## HOUSE RATS

These pests should be handled by trapping if possible. Spring traps should be used, baited with fat bacon. When traps fail, a poisoned bait made by mixing barium carbonate with bananas, hamburger steak, or moistened bran mash in the proportion of 1 part of poison to 4 parts of the carrier may be used. The baits should be renewed daily and any uneaten baits removed.

#### RABBITS

If very abundant, rabbits must be fenced out of young orchards and gardens to avoid serious damage. Shooting and poisoning are the principal means of destruction. An application of whitewash containing bitter aloes to the trunks of young trees is sometimes recommended, but this has not been shown to be of much value in actual practice.

Soaked, chopped alfalfa sprinkled with strychnine, paris green, or white arsenic is very effective in destroying cotton-tail and brush rabbits.

## HOUSEHOLD PESTS

## ANTS

Of the two dozen or more species of ants infesting houses more or less regularly on this continent, practically all have been introduced and are of tropical origin. Among the several species of very tiny ants invading the pantry is Pharoah's ant or the little red ant; the very large, almost black native carpenter ant nearly ½ inch in length may also invade the house. Between these two extremes in size are our numerous common house invaders—one species worthy of special mention being the Argentine ant, *Iridomyrmex humilis* Mayr, a comparatively recent introduction from South America into Louisiana, thence to California, and spreading where climatic conditions are fairly tolerant. This species of ant is without question a serious foe not only to householders, but also to fruit growers, since it is a strong ally of the dangerous mealybug of the orchard and vine.

They have been guided by their keen sense of smell to food and before you know it scouts will have returned to the nest and soon a line will be established. Scraps of meat, crumbs of cake, bread, sugar and the like, left on shelves, sink or other open places will certainly soon attract ants. Cleanliness is essential to ant control; these busy little creatures find food particles which only a vacuum cleaner or hot soapy water with elbow action will remove. Dusting ant powders in crevices around the pantry and across the trails will generally act at least as a repellent. The most effective ant powders contain sodium fluoride as the principal ingredient.

House-invading ants can usually be traced to their colonies out of doors in the lawn, dooryard or under the house. Frequently much good can be accomplished by simply drenching the nest with boiling water, or kerosene. The distribution of ant poison in cans and other receptacles in the yard and around the foundation of the house must be done with some caution because of the danger to young children and domesticated animals. Sodium arsenate is the poisonous element used as a rule in ant syrups.

For the Argentine ant use formula 8 or 9, or buy special Argentine ant poison.

Homemade containers for the latter poison may be made by punching small holes around the tight-fitting tops of cans and then dipping in hot paraffine to prevent rusting. A sponge is placed in the bottom and thoroughly wet with the poison, the lid is securely fastened, the container marked "Poison" and then hung up under or in the house, or in the garden, away from the reach of children. Small fruit jars with holes punched in the lids may be used instead of cans, and if screwed very tightly are less likely to be opened by children.

The Argentine ant frequently plays an important rôle in the orchard in relation to mealybug nurture, hence control here may be highly desirable. The same arsenical formula is recommended as above for this species, and the perforated cans may be hung in the lower branches or variously distributed both on the ground and in the trees.

## **BEDBUGS**

The common bedbug, Cimex lectularius Linn., is a frequent visitor in bunk houses, lodging houses, and oftentimes in the 'best-regulated households.' The full-grown 'bugs' are oval, reddish brown, wingless insects flattened to facilitate their entrance into narrow crevices and possessed of a characteristic odor that often signals their appearance.

They are nocturnal in their feeding habits, hiding away during the day in any place that is fairly dark and which furnishes them an opportunity to crowd into a small crevice. The crevices of wooden bedsteads, floors, loose baseboards, and torn wall paper are favorite places of refuge. The female lays from 75 to 100 eggs in her hiding place which hatch in about a week into tiny bed bugs closely resembling the adults except for size. From 45 days to a year is required for the development to the adults stage, depending on the availability of food. Eight to ten weeks generally suffice.

If many rooms are infested, fumigation is usually the most satisfactory method of control. Hydrocyanic-acid gas (cyanide) is the most efficient fumigant for this pest, but its use should not be attempted by an amateur.

Calcium cyanide is said to be a promising substitute for sodium cyanide for house fumigation. It is recommended that 2 pounds to 1,000 cubic feet of space in the average fairly well-built residence, in general, be used. Fumigation should be for a 24-hour period, somewhat longer than necessary, but this is advisable to insure satisfactory results. It should be weighed outdoors to lessen the danger from the gas. One should work rapidly, for gas is given off then, as indicated

by the slight change in color. Place plenty of newspapers on the floor: the cyanide may stain the floor and especially linoleum through one or two thicknesses of paper. The material should be scattered very thinly on the papers.

Sulfur fumigation, accomplished by burning 4 pounds of flowers of sulfur for every 1,000 cubic feet of room space is satisfactory if all tarnishable metals and vegetable-dyed materials are removed and care is taken to carefully avoid all leakage by stopping cracks and keyholes with wet paper. Gasoline or mercuric chloride (1 to 500 solution) applied to bedsteads, floors, and other hiding places is efficient. The mercuric chloride preparation should be applied with a mop. In case it is necessary to apply by hand, rubber gloves should be worn to protect the skin. For mattresses, bedding, and like materials no treatment is superior to steam sterilization where the necessary facilities are at hand. By use of this medium, death to all stages is accomplished in a few moments if the steam has direct access to the insects. Where large bundles or piles of mattresses are placed in a steam sterilization chamber, it is necessary to produce a partial vacuum followed by 15 to 20 minutes' exposure to steam at 20 pounds pressure.

Where it is possible to heat the infested apartments to 130° Fahr. for 12 to 24 hours, as is often the case in the summer time in buildings equipped with a heating plant, good results may be obtained.

Infested bedsteads that can be 'taken down,' may be dipped in vats of mercuric-chloride solution, or if metal, fine results are obtained by heating all parts with a plumber's blow torch until the paint starts to blister, care being taken not to overlook the springs at the time of treatment.

## COCKROACHES

Although most cockroaches have fairly well developed wings, they are typically running insects, scurrying hither and thither under cover of darkness, for they are night prowlers, hiding away in dark crevices during the day. Thus old ill-kept dark houses with warm kitchens and pantries in winter, are most commonly invaded by cockroaches. These insects, of which there are four or five house-inhabiting species in this country, notably, *Blatella germanica* (Linn.), the crotonbug, are particularly disgusting for two reasons, first, owing to an indescribably offensive roachy odor which is deposited on everything with which they come in contact, and secondly because of their indiscriminate and dangerous feeding habits. Roaches have biting mouthparts like those of grasshoppers and consequently actually nibble their food bit by bit. They are particularly fond of sweet and

starchy matter. Their fondness for starchy substances leads them to do considerable damage at times in loosening hat bands, shoe linings, bookbindings, etc.

The female cockroach carries around with her a dark brown podlike structure which protrudes conspicuously from the tip of her abdomen. This is the egg case or oötheca enclosing the eggs. When the eggs are about ready to hatch the egg case is deposited in some warm dark niche and soon the little roaches emerge. These are at first wingless, but gradually after molting their skins from five to seven times, they reach the winged state and mature size.

To control the cockroach pest one must bear in mind that daylight is its greatest enemy. Do away with all old-fashioned sink cupboards. Open, clean spaces where sunlight or at least broad daylight may freely enter will never harbor cockroaches.

One of the most effective simple means of ridding premises of roaches is dusting with commercial sodium fluoride, either pure or diluted one-half with some inert substance such as powdered gypsum or flour. Numerous practical tests conducted in lunch rooms, bakeries, milk-bottle exchanges, etc., in Washington, D. C., by the Bureau of Entomology, United States Department of Agriculture, have shown that with the use of this substance roaches can be completely exterminated with very little trouble and cost and with none of the possible dangers which attend the use of hydrocyanic-acid gas. With the use of a dust gun or blower the sodium fluoride can be thoroughly dusted over the shelves, tables, floors, and the runways and hiding places of the roaches. The immediate effect is to cause these insects to come out of their retreats and rush about more or less blindly, showing evidence of discomfort, to be eventually followed in the course of a few hours by their death. These dead or paralyzed roaches can be swept up and burned and complete extermination is effected within 24 hours. It is not definitely known whether the sodium fluoride acts as a contact insecticide through the breathing pores or as a stomach poison. Probably, however, it acts in both ways, inasmuch as it has been found to kill caterpillars fed on foliage dusted with this substance.

Powdered borax enters also into the composition of many of the so-called roach powders. This substance may be used either pure as a poison or repellent or mixed with some other substance to render it attractive to the insects. Several correspondents have reported great success from the use of a mixture consisting of one part of powdered borax to three parts of finely pulverized chocolate, this mixture to be freely sprinkled about the infested premises.

## CLOTHES MOTHS

Clothes moths, carpet beetles, fleas and some other household pests thrive best in situations where there is relatively little disturbance. Clothing used almost daily and other fabrics subject to frequent handling, brushing, or sweeping are fairly immune from injury. Woolens and furs are most likely to be damaged while not in use during warm weather. These, before being laid away, should be thoroughly aired, brushed, and carefuly examined for the presence of the destructive larvae. Then they should be packed in tight cedar chests or other tight boxes, preferably with some naphthalene, paradichlorobenzene, or camphor, as these latter materials are of some service as repellents. A very effective and cheap method of storing articles for the summer is to put them in tight pasteboard boxes or bags and seal the covers firmly with strips of gummed paper.

Valuable furs and similar articles are frequently deposited with storage companies. Experiments have shown that all danger of injury by clothes moths and their associates may be obviated by keeping the temperature at about 40° Fahr., this is sufficiently low so that insects, if present, will remain in a dormant and, therefore, harmless condition.

A very effective and safe method of destroying insects in stored furs and garments is by fumigation with carbon tetrachloride, using 6 pounds to 100 cubic feet of space. The insecticide is placed in large, shallow pans so as to assure rapid evaporation, and these in turn on hot soapstones, and the fumigation continued for a period of 24 hours. It is essential that the pans be large enough and the heat sufficient to vaporize the insecticide speedily; otherwise the results may not be entirely satisfactory.

In some instances superheating, especially if an electric heater is available, may be the best method of dealing with the situation. A temperature of 130° Fahr. throughout the storeroom or clothespress for a period of 10–20 minutes ought to be amply sufficient, though it is advisable to allow some margin in the interests of thoroughness.

Occasionally a clothespress becomes badly infested by clothes moths or carpet beetles. All garments should then be removed, aired, and thoroughly brushed and care taken to destroy any larvae which may not have been dislodged by this treatment. The clothespress itself should be thoroughly brushed and cleaned. These measures should afford relief. It is a very poor plan to have in the attic or some unused part of the house miscellaneous woolens or other materials in which

the pests can breed unrestrictedly, as such places are likely to serve as centers for the infestation of more valuable articles.

Paradichlorobenzene is a white crystalline substance which vaporizes slowly at ordinary temperatures, forming a gas apparently heavier than air. This gas is non-poisonous to man, but poisonous to clothes moths and other fabric pests when they are exposed to it in tight containers. The fumes do not injure fabrics. It can be purchased in tin cans containing from 1 to 10 pounds, from drug stores or direct from the manufacturing chemists at a cost of from 15 to 45 cents per pound, according to the quantity purchased. Paradichlorobenzene is similar in general appearance to naphthalene flakes and appears to be quite as effective as naphthalene when used in accordance with directions for the use of naphthalene, and in the same amounts. It is a relatively new remedy which bids fair to become as well known as naphthalene in moth control. Use about 1 pound of crystals for each 10 cubic feet of space.

## FLEAS

While there are several species of fleas, the great majority of them interchange hosts, i.e., the cat and the dog flea, *Ctenocephalus canis* (Curtis) is just as likely to attack humans as cats and dogs; the same holds true for the human flea, *Pulex irritans* Linn. Hence the following general statements will apply.

Fleas may deposit their eggs on the infested animal, but more eggs are deposited off the host than on the host, and in the absence of a sticky secretion practically all fall off the host when it shakes itself. A flea deposits, as a rule, from 15 to 25 glistening white eggs. These hatch ordinarily in less than a week. The larvae are very active, sparsely haired maggots about ¼ inch long when full grown. They subsist on fecal matter, dry blood, decaying vegetable matter, etc. In three or four weeks the larva (maggot) spins a cocoon and pupates. The entire life history, i.e., the period from the egg to the appearance of the adult flea, is passed in from four to six weeks or over.

The control for fleas is rather closely linked with the presence of domestic pets, either as regular entrants to the house or as itinerant visitors to the basement. Rats and squirrels also fall in this latter category. Poultry yards on or near the premises also demand attention. The exclusion of all animals from the basement, the periodic treatment of poultry yards and the regulation of dogs and cats permitted in the house constitute the preventive measures.

Domestic pets may be rid of fleas by frequent dusting with sodium fluoride, care being taken to rub it thoroughly into their coats and to

perform the process in such a place that all fleas dropping from the animal may be gathered up and burned, as many are merely stupified and will recover in a short time. Small animals may be successfully treated by washing with a heavy lather of naptha soap, wrapping the animal when well lathered in a towel for 10 minutes, after which a thorough rinsing is given.

Mats upon which dogs and cats sleep should be shaken out over kerosene or fire every day or two in order to destroy the eggs and larvae. Next, all carpets and matting of the old-fashioned type, tacked down and covering the entire floor, must be dispensed with (rugs may be substituted) unless an insecticide can be found which may be applied to the carpet in wetting quantities without producing injury to the fabric. With the removal of the carpets and matting the floor can easily be run over with a 'dry' mop moistened (not soaked) with kerosene. All parts of the floor in all parts of the house must be reached. The odor of kerosene is not particularly disagreeable and at all events will soon leave. Treatment should be repeated at least once every three or four weeks during the flea season. If properly applied, this method will certainly control the fleas.

Fleas also breed abundantly in the loose manure and debris in stables, hog pens, chicken houses, etc. Treatment with a high-flash-point light crude oil, fuel oil, or kerosene is recommended. This is applied to the floors and ground in the form of a spray.

To treat barnyards, basements, and floors of outhouses, kerosene may be applied by means of an ordinary hand spray pump, the kind commonly used for garden purposes.

## FLIES

The common house fly,  $Musca\ domestica\ (Linn.)$ , lays its eggs on freshly deposited manure heaped in piles, also on heat-producing piles of vegetables and animal matter. These hatch in about two days into tiny glistening white, footless maggots that grow rapidly for approximately a week until about  $\frac{1}{2}$  inch in length, when they migrate from the moister part of the manure to a drier portion; here they turn into brown, barrel-shaped pupae, from which they emerge as full-grown flies in about four days.

The blow flies, flesh flies, buzz flies, or meat flies, as they are variously called, will also breed in manure and garbage, but prefer the bodies of dead animals left exposed on the ground or buried in shallow holes.

When garbage is fed to animals or left exposed, unless extra precautions are taken, fly breeding will occur in the garbage itself and even in moist soil that has become saturated with liquid food material, urine, and feces.

Manure should be removed at intervals of less than one week and spread out in a layer sufficiently thin to cause immediate drying. If it must be kept on the premises for longer periods it should be stored in fly-tight bins or composted in neat, clean-edged, narrow piles.

Dead animals should be incinerated or if buried the carcasses should be liberally sprinkled with lime or crude oil and the ground well tamped.

Flies are best poisoned inside the house by sweetened 2 per cent solutions of formaldehyde mixed with milk and exposed in saucers at night ready for flies early in the morning, other sources of water having been removed.

The larvae may be destroyed in manure by sprinkling the pile with borax at the rate of ½ pound to 10 cubic feet of manure and following this application with enough water to carry the borax at least 6 inches into the mass. Repeated borax treatment will make such manure injurious to plants if used as a fertilizer.

# MOSQUITOES

The mosquito must have water, if only a thimbleful, in which to develop. In some species the eggs may be laid on mud, but in nearly all cases the eggs are deposited on the surface of the water, either in boat-shaped masses of 250 to 450 eggs (culicine), or singly in heaps of approximately 200 eggs, the individual eggs arranging themselves on the water in geometric designs (anopheline). These eggs hatch in from one to three days. The larvae are called wrigglers. These creatures are very tiny at this time and are hardly visible to the naked eye, but in a few days they become fairly conspicuous objects.

The wrigglers most commonly seen hang from the surface of the water at an angle, with their heads down. This is the characteristic position of the culicine (Culex) species. Less conspicuous wrigglers, very different from the above and usually remaining unseen unless attention is called to them, lie parallel with and closely adherent to the under surface of the water film. These are the larvae of the anopheline (Anopheles) species, or malaria bearing mosquitoes. During this and the following stage these organisms are air-breathing, notwithstanding their aquatic habitat. By keeping the mosquito wriggler totally under

water it can be drowned eventually like any other air breather. The reason then that wrigglers come to the surface of the water is that they must have air, which they secure by means of their protruding siphons or air funnels. Oil placed on the surface of the water in mosquito control not only causes suffocation of the larvae by covering over the surface of the water or by plugging the breathing tubes, but also the volatile gases of the oil actually penetrate the breathing system and destroy life.

The wrigglers secure food by browsing on the algae and other tiny plant life growing on the sides and at the bottom of the pool, or by feeding on smaller organisms at or near the surface of the water. It is not difficult to observe the movements of these creatures as they squirm about while breathing at the surface or wriggle down to the bottom, using their well-developed jaws in nibbling food. Growth, during this stage, is greatly influenced by temperature. In summer this stage requires from seven to eight days but may require as long as six or eight weeks in early spring or late autumn. Many of the culicine mosquitoes appearing early in the spring in California have their origin from overwintering wrigglers. Many mosquitoes hibernate during the winter under buildings, among loose debris, or in other protected situations, coming out to feed in the spring, or even appearing on warm winter days. The Anopheles wrigglers usually require about a half more time to develop; thus if Culex requires ten days, the former will require about fifteen days. Anopheline wrigglers have not been found in California during the winter months nor until the spring is well advanced. Anopheline adults often seen in considerable numbers as early as February and March, are hibernated individuals and upon them depends the future generation, a fact which lends emphasis to the need of careful autumn control work.

The next stage after the larva or wriggler is the pupa or tumbler, also aquatic, but provided with a pair of air trumpets situated far forward as compared with the single breathing siphon of the larva. The tumblers of the two groups of mosquitoes do not differ very greatly, though the *Anopheles* are more strongly arched and the head end is longer than in *Culex*. This stage is comparatively short, only two to four days being thus spent, when the skin splits dorsally and the winged insect emerges, balances itself on the empty shell, spreads its wings and is soon off to find food. Undoubtedly many mosquitoes never have the privilege of sucking the blood of warm-blooded animals, but where this is available the female mosquito fills herself full and the development of eggs proceeds. Laboratory observations prove that

bloodsucking is not absolutely necessary for the development of eggs in some species.

The culicine mosquitoes require in midsummer at least ten days for their complete development from the egg to the adult. Fifteen to eighteen days seem to be the shortest time for the *Anopheles* to pass through this process. In early spring the total time is correspondingly longer, owing to the lower average temperature. Observations show that the newly emerged female mosquito lives on an average of from thirty-five to forty days during the summer. The male lives only three or four days, rarely longer, even under best conditions. Female mosquitoes commonly hibernate during winter and may pass several months in this state, appearing in the spring to propagate the species.

Wherever mosquitoes occur in abundance one may infer at once that their breeding place is near, almost certainly not over a quarter of a mile and usually in the immediate vicinity (salt-marsh mosquitoes excepted). Perhaps it is a small pool caused by a leaking hydrant. Herein lies the importance of careful inspection. The trouble may be traceable to one or more of many conditions, among them possibly a break in an irrigation ditch causing an inundation of 2 or 3 inches over an adjacent pasture, or improper drainage after irrigation; possibly a small settling barrel or tank for drinking water; a horse trough, can, tub, barrel, or other receptacle, or exposed tanks; perhaps only a broken gourd. These seemingly minor matters are usually of far greater importance than is a reservoir or a river. Creeks, particularly in late summer, may be a serious menace if the water stands in pools, or runs sluggishly along the weed grown edges.

Permanent methods of control are always preferably applied, namely, keeping the ditch in good order, caring for the disposal of excess water after irrigation, and guarding against overirrigation, repairing leaking hydrants, burying worthless objects which may hold water, such as tin cans, gourds, etc., covering or screening settling tanks, barrels, etc. Where possible, permanent bodies of water, such as ornamental ponds, should be stocked with surface-feeding fishes such as *Gambusia*.

Where permanent corrections must be delayed or are impossible, then oil or other larvicides must be applied to the surface of the water. During midsummer it must be borne in mind that all our common culicine mosquitoes require but ten or twelve days to pass from the egg to the winged insect. Hence any body of water which stands exposed to these insects for a period of ten days or over is a menace, and must be treated or otherwise controlled.

If oil is used, a mixture of approximately half crude oil and half kerosene is recommended; this can be easily applied by means of a spray pump, repeating the operation once every twelve days during the summer and somewhat less often in early spring and late autumn.

Far too little attention is paid to properly screening the house, particularly bedrooms and sleeping porches, against mosquitoes. The *Anopheles* or malaria-bearing mosquito is not a large insect, hence a fine-mesh screen (1-mm. mesh) must be used and must be properly fitted and kept in repair. It is the mosquito which finds its way indoors that is most dangerous, hence hunting and destroying ('swatting') the last mosquito before retiring is time well spent.

## SILVER FISH MOTH

This wingless leaden-colored insect sometimes becomes important through its eating starchy material such as laundered sheets, bookbindings, wall paper, etc. It is controlled by use of a bait composed of 10 parts of starch to 1 part of white arsenic.

## SOWBUGS—See p. 83

# TULE BEETLE OR STINK BUG, Platynus maculicollis (Dej.)

These beetles cause great annoyance by entering houses, often in great numbers, in search of shelter in the autumn time when they are driven by the rains from the lowlands where they breed and feed on other insects along the river margins and in moist places. Once in the house they are hard to get rid of, especially if the house is moist, but a well-warmed and dry house does not serve them well. Keeping doors and windows well screened and all cracks closed, particularly when lights are burning, will help considerably in keeping them out when they are making their flights. The invasions are only temporary.

# VENOMOUS INSECTS, SPIDERS, ETC.

Among the few venomous insects and spiders, the most noteworthy are the so-called 'kissing bugs' (cone noses), the black widow or hourglass or shoe button spider, the pajaroello tick, and the scorpion.

Two species of kissing bugs, *Triatoma protracta* Uhler, a black species, also known as the China bed bug or cross bug, and *Rasahus thoracicus* Stal., the two-spotted corsair, a reddish-brown species with

a large reddish-yellow spot on each wing cover, inflict particularly painful bites, which may result in more or less severe symptoms such as vomiting and rash.

These insects usually bite at night, but may also do so when disturbed during the day. Bathing the wound immediately with a 1 to 1,000 solution of mercuric chloride (poison) or strong ammonia will afford some relief. The same treatment may be applied for the sting of scorpions.

The black widow spider, Latrodectes mactans (Fabr.), may inflict a bite resulting in serious consequences and in the event of a bite by this spider a physician should be consulted immediately. This spider is also known as the 'shoe button spider' because of its resemblance to a large, shiny, black, more or less globular button. Both the body and long brownish-black legs are almost devoid of hair. Beneath the abdomen is a brick-red marking resembling an hourglass, whence the name 'hourglass spider' also applied to this species.

## ANIMAL PARASITES

## CATTLE

Ear Ticks, Ornithodorus megnini Duges.—This tick lives its entire life within the auditory canals of the ears of domesticated animals, particularly cattle, except when it leaves to deposit its eggs in the ground. The young ticks hatching from these eggs crawl on the bodies of available animals and enter the ears. Control must be by individual treatment. The application of a half-and-half mixture of cottonseed oil and pine tar in quantity sufficient to wash the auditory canal is very effective.

Horn Flies, Lyperosia irritans L.—These flies, about one-half the size of the common housefly, cluster about the rump and head of cows, sucking blood and constituting a serious nuisance in the case of dairy cattle. They deposit their eggs on the freshly deposited cow manure. The young maggots live in this material until ready to change to an adult fly, when they burrow into the surrounding earth to pupate. The life history requires from 10 to 16 days.

Corrals should be cleaned of manure weekly or dragged with a heavy brush drag daily to break up the clots of manure and thus dry them out.

Biting Lice, Trichodectes bovis (Linn.).—The biting louse may be differentiated from the sucking louse by its round head and the fact

that it is never found with its mouth parts imbedded in the animal's flesh. It may be controlled by one dusting with sodium fluoride (commercial) mixed with flour in even proportions, or by dipping, spraying, or bathing the animal with a coal-tar dip (p. 112) at intervals of ten days.

Sucking Lice, Haemotopinus eurysternus (Nitzsch) and Linognathus vituli Linn.—These lice suck the blood of the animals and may be distinguished from the biting lice by their pointed heads and the fact that they are generally found with their mouth parts plunged into the animal's flesh. Sodium fluoride, so successful for the biting lice, is useless against this class of lice. Coal-tar dips (p. 112) applied as a dip or spray or rubbed on are effective but must be repeated at the expiration of ten days to be successful. Raw linseed oil applied with a brush at intervals of a week will also control both types of lice.

Lungworms, Dictyocaulus viviparus Bloch.—These worms are parasitic in the air passages of the lungs. The eggs containing living young are coughed up and swallowed, hatch out in the small intestine, and, after spending a period outside the body are taken in again with food or water, and after penetrating the small intestine are borne back to the lungs. They cause serious damage by producing a collapse of those portions of the lungs from which the air supply is shut off by the blocking of the bronchioles, thus forming a favorable medium for the growth of pathogenic organisms that may actually cause the death of the infected animals. Chloroform injected into the nostrils in quantities sufficient to make the animals slightly groggy kills large numbers of the lungworms and greatly facilitates recovery. (See "Sheep," p. 103, regarding the danger of chloroform treatment with this animal.) Sufficient food and proper shelter are very important. Infection is incurred in moist, swampy localities. Wherever possible such areas should be eliminated from the range or fenced off and drinking water supplied in troughs high enough to avoid contamination with feces.

Ticks.—Various ticks attack the bodies of cattle. Where these occur in large numbers or where the tick concerned is the Texas Fever Tick, *Margaropus annulatus* Say, which may be recognized by its chestnut-colored shield and the fact that its first pair of legs originates on the 'shoulders' and not close to the shield, measures should be taken for control. Dipping in an arsenical dip (formula 4) is most satisfactory. If only a few animals are concerned, spraying may be substituted for the dipping.

Warbles, *Hypoderma lineata* de Villers and *H. bovis* De G.—These maggots, which cause the lumps or swelling on the backs of cattle, are

the larvae of a fly resembling a bee which deposits its eggs on the heels or legs of cattle. On hatching, these maggots bore into the skin and penetrate to their position on the back beneath the skin. When about ready to change to a fly a hole appears above the maggot which is used for its exit. It then falls to the ground and burrows into the earth for 2 or 3 inches, whence it emerges in about three weeks as a full-grown fly ready to deposit eggs on other cattle. The control is individual in that the maggot when 'ripe' must be forced out of the lumps on the back and destroyed. Care should be taken not to crush the warble in the wound, for such accidents sometimes produce serious poisoning. If this happens the wound should be carefully washed out with water to which salt at the rate of 2 teaspoonfuls to the pint has been added.

## DOGS

Demodectic or Follicular Mange.—This is commonly called the 'red mange' of dogs. It is diagnosed by the presence of a microscopic elongated mite known as *Demodex folliculorum* Simon, which burrows into the hair follicles. The chances of cure are slight, and valuable or valued dogs should be placed under the care of a skilled veterinarian where facilities are available for the production of auto-vaccines, as it is considered by some that this malady is caused primarily by bacteria, the mites being merely of secondary importance. Itchthyol (10 per cent) and formalin (5 per cent) applied direct are both highly recommended.

Fleas.—See "Household Insects," p. 94.

Lice.—See "Cattle," p. 100.

Mange or Scabies, Sarcoptes scabiei var. canis Linn.—Affected parts should be thoroughly washed with warm water and soap until the skin is thoroughly softened. Sulfur ointment made by mixing sulfur and lard should be carefully rubbed into the skin. This should be repeated every five days.

Roundworms, Toxascaris limbata R. & H. and Toxocara Canis Werner.—These worms normally inhabit the small intestines but are great wanderers and are often found in the stomach, which accounts for their name of 'maw' worms. The eggs are ingested with food contaminated by the feces of infested dogs. The eggs hatch in the stomach and the larvae penetrate to the lungs, into the air spaces of the latter, up the windpipe and down the esophagus to their final resting place in the small intestine. This migration is often the cause of serious pneumonic difficulties in puppies.

Control is by administration of oil of chenopodium at the rate of 1 cubic centimeter for each 20 pounds of body weight combined with 1 ounce of castor oil.

Salmon Poisoning.—Dogs fed uncooked salmon, steelhead, or trout taken from certain streams in the northern part of the state become infested with an intestinal flatworm or fluke that causes a serious illness commonly known as 'salmon poisoning.' This fluke, Nanophyetus salmincola (Chapin), which is microscopic in size, passes a part of its life history in a snail which inhabits typical trout streams. The young flukes leave the snails to penetrate the body of the fish, where the young fluke remains encysted until its host is eaten by a dog or some other animal that acts as the final host in which the fluke reaches maturity. There is no satisfactory treatment, although a heavy purging sometimes saves the dog if applied early enough. Cooked fish is, ourse, safe.

**Tapeworms.**—All tapeworms of the dog have an intermediary host, i.e., another animal in which the tapeworm lives and which must be eaten by the dog in order to infect the latter. The various tapeworms of dogs find their intermediary host in lice, fleas, rabbits, and sheep, among others. The commonest tapeworm of dogs is *Dipylidium caninum* Linn., the double-pored tapeworm which passes its larval stage in the dog flea or louse.

Biting lice or larval fleas become infected with the larval stage of this parasite by eating particles of the dog's feces containing the eggs of this worm. The young form develop in the louse or flea and when these are eaten by the dog the larval tapeworm avoids digestion, attaches itself to the lining of the intestine and becomes a mature tapeworm.

The most efficient treatment is arecoline hydro-bromide in ½-to ¼-grain doses placed on the tongue of the animal. The dosage depends on the size and breed of the animal. Airedales react satisfactorily to the minimum dose but greyhounds sometimes require ½ grain. With valuable dogs or toy dogs this treatment should be administered by a veterinarian who would be able to recognize symptoms of poisoning and apply the necessary antidotes. No preparation is necessary and the tapeworms are generally eliminated in from 10 to 15 minutes.

#### SHEEP

Flukes.—See Extension Circular 17.

**Head Maggot,** Oestrus ovis (Linn.).—These pests are the larvae of flies that deposit their living young near the nostrils. The young

migrate up the nasal cavity penetrating to the sinuses, where they are often trapped by their growth in size. Their presence may be detected by the attitude of the infected animal, which stands head down and inclined to one side and at intervals follows the inclination of its head around in circles. This may be distinguished from 'gid' by the fact that with head-maggot infestations there is a discharge from the nostrils. Some relief may be had by causing the animals to sniff up red pepper, the larvae being discharged by violent sneezing. Prevention is accomplished by the use of 'salt logs' made by boring 2 to 3-inch holes in a log, filling the cavities with salt and smearing the circumference of the holes with soft tar. The animal in attempting to get the salt keep the muzzles painted with tar which acts as a repellent.

Lungworms, Dictyocaulus filaria Rud.—See "Cattle," p. 101, for general consideration. Little can be done in the way of treatment for sheep affected with lungworms because they are very susceptible to chloroform, which consequently cannot be used for these animals. Good food and comfortable shelter will generally accomplish the desired end, although the sanitary precautions should not be overlooked.

Scab.—This disease, which manifests its presence by the 'tagging' of the wool and crusting of the underlying skin, is caused by a microscopic mite, *Psoroptes communis* var. *ovis*. Hering. These mites puncture the skin, causing an intense itching; the roughening of the skin and eventually a crustiness causes the wool to fall out or 'tag.' Control is by means of dipping in lime-sulfur dip (formula 40). Pastures which have been used for infested sheep should not be utilized for clean sheep for three months unless drenching rains have intervened.

Stomach Worms, Ostertagia of various species but predominatingly O. circumcincta.—These minute, hair-like worms inhabit the fourth stomach and cause considerable loss, particularly in lambs. They are often overlooked on account of their small size. To detect their presence at autopsy, cut a slit in the fourth stomach and without spilling the contents hold the organ in a bright light. If stomach worms are present, they can be detected by their motion in the stomach contents. The eggs of these worms pass from the animals with its feces and hatch in the presence of moisture, and the young worms are ingested with contaminated food or water. A 5 cubic centimeter capsule of carbon tetrachlorethylene is a very efficient dosage but must be repeated at intervals as long as the sheep are kept on infested pastures, the time between treatments depending on the severity of the infestation. (See Agr. Ext. Cir. 17.)

Wool Maggots.—These pests are the larvae of flesh flies such as Lucilia sericata (Meigen) and Phormia regina Meigen, that, attracted by the odor of soiled wool, attack first the wool and later the flesh of the sheep. The points of attack are largely confined to the area about the hind quarters where the wool becomes soiled with feces. 'Crutching,' the clipping of the wool around the anus and inside the hind legs, helps prevent infestation. Infested flesh should be cleaned of maggots by the application of sheep dip and the odor of putrefaction destroyed by formaldehyde or pine tar in order to prevent further infestation. 'Jetting' of the hind quarters under 100 pounds pressure with sheep dip to which white arsenic, at the rate of 5 pounds of arsenic to 250 gallons of dip, has been added is curative and acts as a protection for from one to three months. The bodies of dead animals, in which these flies also develop in enormous numbers, should be incinerated.

## SWINE

Lice, Haematopinus suis Linn.—The control of the sucking lice of hogs is extremely important. The irritation, together with the loss of blood occasioned by their attacks, is the cause of considerable losses when taken in the aggregate. Crude oil is the best remedy. This may be applied by soaking it on burlap-wound posts in the corrals against which the hogs will rub, or by applying it to the surface of their wallows if the latter are located in the shade.

Mange.—Common, see "Scab," under "Sheep," p. 104. Demodectic, see "Dogs," p. 102.

The control of demodectic mange on hogs is seldom of economic importance, as the disease affects only the skin and is seldom serious during the relatively short life of the animal. The same measures may be taken as for dogs. The snout and face about the eyes are the parts generally affected.

Roundworms, Ascaris lumbricoides Linn.—For life history see "Dogs," p. 102. Starve the infested animals for 24 hours. Administer individually 4 cubic centimeters of oil of chenopodium in 60 cubic centimeters of easter oil per 100 pounds of body weight. Care should be taken not to introduce the dose into the retropharyngeal recess that lies just above the esophagus or into the windpipe. Both of these accidents generally terminate fatally.

## APIARY PESTS

Wax Moths, Galleria mellonella (Linn.) the greater and Achroia grisella Fabr. the lesser.—These moths are serious pests of stored combs and comb honey. Their depreciations in colonies of bees is limited to the weaker colonies in which they riddle the combs by eating the wax. Manifestly, the control for them is the maintenance of stronger colonies. The Italian bees are recommended because they most energetically search out and kill the moth larvae in the colony. Fumigation of the stored combs with sulfur fumes, carbon disulfide, or cyanide gas, is sometimes also necessary.

American Foulbrood.<sup>7</sup>—This is a most serious bacterial (Bacillus larvae) disease of larval bees which is carried largely through honey and the transfer of combs. It may be recognized by the brownish color of the dead sealed larva, the stickiness of the settled putrid mass, the gluepot odor and finally, by the adhering larval scale in the cell. It is necessary to use drastic treatment. The old combs and honey must be destroyed or treated with special care to prevent spreading the causative organism or its spores to clean colonies of bees. The dry combs (free of all honey) may be made sterile by soaking for 48 hours in a solution of 1 gallon of water, 2 ounces of liquid soap, and 1 quart 40 per cent formalin. (See Exp. Sta. Cir. 307.)

Fire is now being used extensively in attempting to eradicate this disease. The bees are killed with calcium cyanide and the whole hive or at least the bees and combs are burned in a deep pit. Care must be used to cover the remains before any bees can get to the honey which does not burn. The hive bodies, tops, and bottoms, after being dipped in boiling lye water and repainted, are again used for bees. A thorough trial of this method is recommended by many authorities.

European Foulbrood and Sac Brood.—These diseases may ordinarily be kept under control by the use of young Italian queens. An infected colony may be dequeened for twenty-one days, then requeened with a young laying queen of resistant stock. Where requeening persistently fails, careful inspection during the first or second cycle of the brood in the spring, followed by burning the few infected colonies, gives complete control. European foulbrood is caused by a bacterium (Bacillus pluton). The cause of sac brood is still unknown.

 $<sup>^7\,\</sup>mathrm{Samples}$  suspected of disease will be diagnosed free by the U. S. Dept. Agr., Washington, D. C.

**Paralysis.**—This is a disease of adult bees. The cause is unknown. Dusting the combs with powdered sulfur and requeening are usually sufficient treatment for control.

The use of resistant vigorous stock cannot be urged too strongly in dealing with nearly all the common enemies and diseases of the hive bee.

Bee Louse, Braula caeca Nitsch.—The louse, an old pest of bees in parts of Europe, has been found in Maryland and Pennsylvania. Little damage has apparently been done in this country since the largest extracted-honey-producing apiary in Pennsylvania has been infested for about fifteen years. The larvae inhabit tunnels in the combs and frass of the hive. Dissemination of the adults may easily be effected in queen-bee shipments and they are certain to appear in this state as a consequence of our wholesale importation of queen bees; in fact they are probably already here. These insects belong to the Diptera or fly group.

Sage Worm, Platyptilia marmarodactyla Dyar.—This insect does serious damage to the black and purple sages, destroying buds in the 'buttons.' Beekeepers in the sage region of southern California are all too familiar with the work of this caterpillar, which is referred to as the 'sage weevil.' Injury is by tunneling through bud after bud in a button until at times practically all have been destroyed. It is not unusual to find 2–3 individuals to a button. No practical measures can be offered toward control.

# FORMULAS AND MATERIALS

#### ARSENICALS

Acid Lead Arsenate (Lead Hydrogen Arsenate, Di-lead Arsenate, Often Labeled 'Standard Lead Arsenate').—The acid type of lead arsenate contains more poison per pound than the basic type, is a stronger poison and acts more quickly. It is, however, somewhat susceptible to the action of other chemicals, particularly those of an alkaline nature (such as soaps, lime-sulfur solutions, etc.), and is more or less dissolved by them when used as a combination spray. In moist climates along the coast, or in continuous damp, cloudy weather elsewhere, whether used alone or in combination with other sprays, some of the arsenic is apt to be dissolved and to cause serious foliage injury.

#### FORMULA 1

Dry ac	id lead	arsenate	(paste,	4 to 8	pounds)	2	to	4 ]	ounds
Water			<b></b>			10	00	gall	ons

Basic Lead Arsenate (Usually Labeled 'Tri-plumbic' or 'Neutral').—The basic type of lead arsenate is a weaker poison and acts more slowly. It is not decomposed, however, by chemicals of an alkaline nature, such as are usually applied with it as a combination spray, nor by the damp weather of the coast regions. It is considered the only safe arsenical to use on stone fruits, beans, or other susceptible plants.

The lead arsenates are usually sold as a paste containing about 50 per cent of water, or as a dry powder. The paste should be thinned somewhat with water and worked into a smooth cream before adding to the spray tank. The powder may be added directly to the tank and mixed by means of the agitator.

For codling moth and most defoliating insects use:

## FORMULA 2

Dry basic lead arsenat	e (paste, 5 to $10$ pounds) $2\frac{1}{2}$ to $5$ pou	ınds
Water	100 gallons	

Dry or powdered lead arsenate contains twice as much arsenic as the paste; therefore use only one-half as much of it.

Zinc Arsenite.—Zinc arsenite is a stronger and more active poison than either type of lead arsenate, and is useful in controlling the various caterpillars which are troublesome on pears and apples in the early spring, but is very apt to cause injury if the application is made after the time of full bloom.

#### FORMULA 3

Zinc arsenate powder	3 pounds
Water	100 gallons

White Arsenic (Arsenic trioxide).—White arsenic is only sparingly soluble in water, although sufficiently so to prohibit its use on plants as an insecticide. Its use as a stomach poison is therefore limited to the preparation of poison baits for the control of grasshoppers, armyworms, cutworms, etc., and to some other cases where the insecticide is not to be applied to growing plants.

# Government Arsenical Dip.

#### FORMULA 4

Caustic soda	4	pounds
White arsenic	8	pounds
Sal soda crystals		~
Pine tar		_
		gallons

Emulsify the pine tar by dissolving 3/4 pound of caustic soda or concentrated lye in 1 quart of water and adding to this 1 gallon of pine tar. Stir until a clear molasses-like liquid results. If a drop of this does not mix perfectly with water, stir in caustic soda until a perfect mixture of tar and water results.

Dissolve the remainder of the caustic soda in an iron vessel (zinc, tin or solder will be corroded) using 1 gallon of water. Then add the arsenic slowly, with constant stirring. The temperature of the solution while mixing should be just below boiling. Add the sal soda after the arsenic is dissolved, stir, then make up to 5 gallons.

To prepare the dip dilute the emulsified tar with two or three times its volume of water and pour this into the dipping tank, after the latter is three-fourths full. Add the arsenical solution in the same way and make up to the desired amount.

This solution is very poisonous and should be handled and disposed of with great care.

# Poison Bran Mash.

Fulsun Bran Masn.	FORMITA 5		
	FORMULA 5 La	arge quantity	Small quantity
Bran	2	5 pounds	1 pound
White arsenic		1 pound	1 teaspoonful
Molasses (cheap blackstrap	preferred)	2 quarts	4 teaspoonfuls

Mix the arsenic and the bran dry and add the molasses which has been diluted with water. Add enough water to make a dry mash which will broadcast easily; mix thoroughly.

# Citrus Bran Mash.

#### FORMULA 6

White arsenic1	pound
Molasses (cheap blackstrap preferred) 2	quarts
Lemons (or oranges) 6	fruits
Water (about)	
	pounds

Mix the above materials as follows: First stir thoroughly the white arsenic, molasses, and water. Grind the lemons, including the

rinds, in a meat grinder, or chop fine, and add to this liquid. Then slowly pour this over the bran and stir thoroughly until an even mixture is secured.

The amount of water to use in the preparation of these baits will vary according to the coarseness of the bran or substitutes. A barely moist mash is preferable to a wet one because it does not harden under the heat of the sun and remains palatable, while wet mash becomes baked and unattractive.

Substitutes in Poison Baits.—Paris green may be substituted for white arsenic in formulas 5 and 6. Alfalfa meal, shorts, or rice meal may be substituted for bran in the preparation of the above formulas.

Sodium Arsenite.—This arsenical is readily soluble in water and is one of the most violent of the plant poisons. It probably acts more quickly than any of the better-known arsenical poisons, and is commonly used in the preparation of weed killers, poison fly-papers, cattle dips for the control of ticks, ant syrups, and to some extent in the preparation of poison baits.

Sodium arsenite may be purchased ready made as a white powder, but it is not always readily obtained at pharmacies, nor can it always be depended upon to contain a uniform amount of arsenic.

	FORMULA 7	Small quantity	Large quantity
Sal soda		2 oz.	2 lbs.
White arsenic		1 oz.	1 lb.
Water (about)		$\frac{1}{2}$ pint	1 gallon

Put all the ingredients together in an iron or graniteware kettle (do not use aluminum) of sufficient size to allow for considerable frothing, and boil 15 or 20 minutes, or until the solution is clear.

# Ant Syrups. Formula 8

	Strong for native ants	Weak for An Large quantity	gentine ants Small quantity
White arsenic	2 oz.	1 oz.	1 scruple
Concentrated lye	1 oz.	1 oz.	½ teaspoonful
Sugar	1 lb.	20 lbs.	1 lb.
Water	1 pt.	3 gals.	1 pt.

The U. S. Bureau of Entomology recommends a later formula for the preparation of Argentine ant syrup which is said to be superior to any other formula tested by them, "on account of its stability at high temperatures, freedom from crystalization, and continued attractiveness."

# FORMULA 9 GOVERNMENT ARGENTINE ANT SYRUP

5.5 /		
Granulated sugar1	2	pounds
Water1	1	pints
Tartaric acid (crystalized)	7	grams
Benzoate of soda	9	grams
Boil slowly for 30 minutes. Allow to cool.		
Dissolve sodium arsenite (C. P.)	4	ounce
In hot water	$_2'$	pint
Cool. Add poison solution to syrup and stir well.		
Add to the poisoned syrup:		
Honey, strained	2	pounds
Mix thoroughly.		

# CALCIUM CYANIDE

Calcium cyanide in the form of flakes and dusts is a comparatively new and important insecticide. It may be applied straight or diluted from 50 per cent to 25 per cent with hydrated lime, sulfur, or other carriers. It is used chiefly as dusts to control aphis, leafhoppers, and other insects, and as flakes or dusts for soil fumigation. Calcium cyanide should never be used when the plants are moist because of burning which may result.

#### CARBON DISULFIDE

Carbon disulfide is a liquid which evaporates quickly when exposed to the air, forming a heavy and inflammable vapor of great penetrating power. In using the material for fumigation, it is essential that it be placed near the top of the chamber in a shallow container in order that the heavy vapors as they are given off may thoroughly diffuse through the air contained in the space to be fumigated. The proper amount to use depends upon the type of room being fumigated and ranges from 10 pounds to about 30 pounds to 1,000 cubic feet in ordinary rooms where the walls and floor have not been made especially tight. The best results are obtained by doing this work when the temperature is above 70° Fahr.

Carbon disulfide is one of the best agents for destroying ground squirrels that have failed to take poisoned grain, or having once survived the poison refuse to take it again. It is most effective if used during the winter season when the ground is wet. The best methods of applying it are by the use of the 'waste-ball' and of the 'destructor

pump.' The common waste-ball method is to pour a tablespoonful of carbon disulfide on a piece of cotton waste, corncob, horse manure, or other absorptive material, and then to throw this as far down the hole as possible, closing the opening immediately with earth. Exploding the gas with a torch before closing the opening is recommended where the ground is damp and there is no danger of fire. The explosion of gas forms new compounds which are poisonous and may diffuse somewhat more rapidly than the vapors of the material. The 'destructor' pumps the vaporized carbon disulfide into the burrow, and is said to be as effective as exploding the gas.

See also "Soil Disinfection," p. 126.

Carbon Tetrachloride.—This may be substituted for carbon disulfide in household fumigation by using it in the same manner and slightly increasing the amount used. It is non-inflammable and consequently safer than carbon disulfide, while its lower toxicity makes it safer for the operator.

# COAL-TAR DERIVATIVES

Coal-Tar Creosote Dip.—Coal-tar derivatives, which may be creosote oil, crude carbolic acid, or cresylic acid, emulsified by means of soap, are used as animal dips. These are sold under various trade names and should be used according to directions. The requirement which has been made for such dips by the United States Department of Agriculture is that when diluted for use they shall contain "one per cent by weight of coal-tar oils and cresylic acid. In no case should the diluted dip contain more than four-tenths of one per cent nor less than one-tenth of one per cent of cresylic acid."

These preparations cannot be used in very hard water except by a preliminary water softening. Hard water may be softened by dissolving lye at the rate of 12 ounces of high-grade concentrated lye to 100 gallons of water; then add the dip.

If the emulsion still breaks or forms in globules after treatment with lye it will be necessary to use lime-sulfur solution or an arsenical dip.

# Crude Carbolic Acid Emulsion.—For citrus trees.

#### FORMULA 10

Fish or whale-oil soap40	pounds
Crude carbolic acid	gallons
Water to make40	gallons

Dissolve the soap completely in hot water, add the carbolic acid and heat to the boiling point for 20 minutes (reserve some water to add in case the mixture begins to boil over). For use, add 20 gallons of water to every gallon of the above solution. The emulsion needs little or no agitation.

# Crude Carbolic Acid and Distillate Emulsion.

# FORMULA 11

Fish or whale oil soap (or liquid soap, 5 gallons)40	pounds
Crude carbolic acid (25 per cent) 5	gallons
Distillate (27°–28° Baumé)	gallons
Water to make50	gallons

Prepare as with formula 10, adding the distillate after the crude carbolic acid. This mixture is specially recommended for mealy bugs on dormant deciduous fruit trees. Dilute 1 to 20 for use.

Soap-Napthalene Repellent.—This is recommended as a repellent for western flat-headed borer and other insects.

# FORMULA 12

Fish or whale oil soap25	pounds
Water	gallons
Flaked napthalene	pounds
Flour	pounds

Dissolve the soap in hot water and stir in flour. Add flaked napthalene and heat to 180° Fahr. until thoroughly dissolved. Cool and store in sealed containers. For use, thin to consistency of paint and apply to trunks and limbs with brush.

#### COPPER COMPOUNDS

Bordeaux Mixture (Average Strength).—This is known as the 4-5-50 Mixture.

FORMULA 13

Bluestone	.6	pounds
Quicklime	20	pounds
Water20	00	gallons

A satisfactory bordeaux mixture may be made as follows: Slake the lime and dissolve the bluestone in separate barrels. Fill the spray tank half full of water, add the dissolved bluestone, strain in the slaked lime while the agitator is running, add remainder of water, and mix thoroughly. In order to hasten solution of the bluestone, it is usually placed in a sack and suspended near the top of the water, since lumps at the bottom of a barrel dissolve slowly. It should be kept from contact with all metals except copper, or the bluestone will be chemically changed and the container corroded. Whatever system of preparation is used, it is desirable to have both the bluestone and the lime as much diluted as possible before the final mixing.

# Bordeaux Paste.

#### FORMULA 14

A. Bluestone	12	pounds
Water	8	gallons
B. Quicklime		
Water	8	gallons

Dissolve the bluestone and slake the lime separately in the amounts of water specified. Then mix together equal quantities of each ingredient, making up only enough for each day's use.

Commercial Bordeaux Mixture.—Several preparations of this sort are on the market in the form of a paste or dry powder to be diluted with water. Objection is sometimes made to these preparations that they will not remain in suspension in water as well as the homemade bordeaux mixture, but some of them are probably as good or better than the average mixture prepared on the ranch. The commercial preparations are more expensive, but also more convenient for use, and are of especial value to the small grower.

Resin-Bordeaux Mixture.—This is for use on plants with very smooth waxy surfaces on which fungicides do not spread and adhere well.

FORMULA 13		
Bluestone	20	pounds
Lime	26	pounds
Resin	10	pounds
Soap (soft)	16	pounds
Water	200	gallons

Melt the resin in an iron pot; then add the soft soap, heat and stir until well mixed and quite soft. Add hot water and boil and stir for some time until thoroughly dissolved. Add this to the bordeaux which has been made in the usual way.

Bluestone (Copper Sulfate).—A soluble compound of copper, the raw material for the preparation of most other compounds of copper. This cannot be used on foliage.

# For dipping grain use:

# FORMULA 16

I ORMOLA 10		
Bluestone	1	pound
Water	5	gallons
Dip for 3 minutes.		
Followed by:		
Quicklime	1	pound
Slaked in water1	0	gallons
Dip for 5 minutes.		

# For washing lemons use:

# FORMULA 17

Bluestone $1\frac{1}{2}$	pounds
Water1000	gallons

Copper Carbonate.—For dusting wheat for bunt, use 2 ounces of copper-carbonate dust to a bushel. The dust should be intimately mixed to thoroughly cover each seed. The copper-carbonate dust should contain 50 per cent of copper in the form of carbonate and hydrate of copper, and should be sufficiently fine to weigh approximately 32 pounds to a cubic foot. The dusted seed may be stored without injury from the dust.

Ammoniacal Solution of Copper Carbonate.—This solution contains no sediment and on drying leaves no unsightly marks. It may therefore be used when the spotting that the bordeaux mixture causes precludes the use of that fungicide. The mixture consists of a solution made by dissolving copper carbonate in ammonia-water in the following proportions:

#### FORMULA 18

Copper carbonate	3	oz.
Ammonia (about)		
Water50		*

Weigh out the proper amount of copper carbonate. Set a very small portion of this aside and dissolve the remainder of it in diluted ammonia (dilute ammonia with water to about 5 times its volume), using only enough ammonia to dissolve it. Then add the portion of copper carbonate which was reserved. This will insure the use of no more ammonia than is necessary. It is better to have a little too much of the carbonate in the solution than to have too much ammonia. The strong solution made in this way may be diluted with the proper amount of water. The copper carbonate may be purchased from the drug store, or it may be prepared at home.

# **GRAFTING WAX**

Many different combinations are used for this purpose, most of them being various combinations of beeswax and resin. The following formula is a good one:

FORMULA 19	
Resin4	pounds
Beeswax1	pound
Linseed oil	-

The ingredients are all melted and mixed together in a kettle. In hot weather use more resin.

Some use 1 pound of tallow as a substitute for the linseed oil. One ounce of lampblack or 1 pint of flour is sometimes added. Asphaltum is used to some extent as a substitute for resin and beeswax, and, in fact, straight asphaltum is used successfully in some cases for grafting wax.

# HEAT AS AN INSECTICIDE AND DISINFECTANT

A temperature of 130° Fahr., as far as records go, if prolonged for several hours, will kill all forms of insect life. This temperature can readily be obtained in well-built buildings which are connected with a steam plant. The first expense of installing radiators is considerably more than fumigation with chemicals, but after-treatments are very much cheaper and without danger to the operators or to the contents of the building.

Higher temperatures of 145° to 180° Fahr. have been reported as successful in a much shorter period of time than the first figure mentioned. As the desired degree of heat, however, must be obtained throughout the entire mass which is being treated, it is not sufficient to heat the room alone to 145° Fahr. or more. Small amounts of provisions or woolen cloths infested with moths may be heated for 30 or 40 minutes, in the oven of an ordinary cook stove, care being taken to avoid scorching heat. A temperature high enough to slightly brown a white paper bag will be found about right. The use of a smoothing iron just hot enough not to scorch will kill the larvae of clothes moths while in the cloth, but other measures must be taken to reach the adult insects.

Hot water is also a useful agent for destroying many fungi and other injurious organisms. See 'Brown Rot or Pythiacystis Rot,' p. 30, the use of hot formaldehyde for seed potatoes (p. 64), "Narcissus Stem Nematode," p. 82, "Bulb Mite," p. 22, and "Soil Disinfection," p. 126.

# HYDROCYANIC ACID GAS

The most effective fumigant in common use is hydrocyanic acid gas, but on account of its danger to the operator, it should if possible be used only under expert supervision.

# MERCURY COMPOUNDS

Mercuric Chloride (Bichloride of Mercury or Corrosive Sublimate).—This is a very poisonous substance and is one of the most powerful of germicides; it is employed to some extent in plant-disease treatment. The usual strength is:

#### FORMULA 20

Mercuric chloride (corrosive sublimate)	1	ounce
Water	8	gallons
Or 1 part to 1,000.		

Tablets to make this strength when added to 1 pint of water may be obtained at drug stores. Distilled or rain water should be used; the solution must not be kept in a metal container. It is also quickly spoiled by contact with clay or an organic substance such as the cut surfaces of potatoes. It dissolves more readily in hot than in cold water.

Another formula is recommended by Mr. C. F. Reimer for disinfecting tools and cuts in pear-blight control work. It will probably be found superior to formula 28 for general tree work of this kind. It is:

FORMULA 21

Mercuric chloride (corrosive sublimate) 1 ounce

Mercuric cyanide 1 ounce

Water 4 gallons

Or 1 part of each ingredient to 500.

For pear-blight work and similar tree disinfection, in the above formula, dissolve the chemicals in 1 gallon of water and add 3 gallons of glycerine. Hot water dissolves the chemical more readily than cold. This spreads and wets surfaces better and does not dry so quickly.

Organic Mercury Compounds.—Complex compounds of mercury have been introduced and have given good results for a number of uses, such as seed treatment, soil disinfection, damping off treatment, etc. These are sold under trade names Uspulun, Semesan, etc., and are used according to formulas given by the manufacturers.

# NICOTINE DUST AND COMBINATIONS

(Formerly known as 'nicodust')

Nicotine dust, invented by Professor Ralph E. Smith, is composed of a carrying substance, like finely powdered kaolin or lime, treated with a concentrated solution of nicotine sulfate, commercially known as 'Black Leaf 40,' or 'nicotine sulfate 40 per cent.'

The nicotine in such combination, especially with lime, becomes very volatile and is quickly driven off by heat. In this form therefore it acts largely as a fumigant, but may be effective as a contact poison as well. As soon as mixed, the dust should be packed in air-tight containers to retain the nicotine content.

The best results in killing insects have been secured when the temperature is over 70° Fahr., and very poor results have followed its use in cold weather. The various strengths are usually denoted by the amount of Black Leaf 40 contained, as follows: 2 per cent Black Leaf 40, 4 per cent, 5 per cent, 6 per cent, 10 per cent, etc. A statement of the actual amount of nicotine is more accurate and is required in the guarantee of commercial preparations.

Arsenate of lead and sulfur are mixed with nicotine dust at the time of manufacture and give convenient combinations for treating different types of insects or insects and fungus diseases at one application. Sulfur-nicotine dust, under actual field tests, appears to be more efficient in killing insects than ordinary nicotine dust containing the same percentage of nicotine sulfate 40 per cent. Thus in the control of the rosy apple aphis, a sulfur-nicotine dust containing 50 per cent of sulfur, 6 per cent of nicotine sulfate 40 per cent, and 44 per cent of hydrated lime gave far better results than a 6 per cent nicotine dust.

The strengths commonly used are 2 per cent nicotine dust for walnut aphis and cherry or pear slug, 5 or 6 per cent for most of the aphids, thrips, etc., and a 10 per cent dust for the more resistant aphids such as the pea aphis. Nearly all of the hairy caterpillars, such as the tent caterpillars, webworms, and thistle butterfly larvae, as well as the velvety cabbage worms, to which the nicotine dust adheres readily, are easily killed with a 6 per cent dust if applied while the caterpillars are quite young. Smooth caterpillars, like cutworms, on the other hand, do not readily succumb to any ordinary treatment with the material. Insects which are protected with a waxy or cottony material, like the woolly apple aphis, the mealy plum louse, mealybugs, etc., are not susceptible to nicotine dust at all. Those which have a wet or slimy covering, like the cherry or pear slug, or glandular

hairs, like the walnut aphis, are easily killed with very weak nicotine content.

Recently, machines for mixing and applying the materials at the same time have been devised. These promise increased efficiency and economy in some large-scale operations. (See Bul. 357.)

# PARADICHLOROBENZENE OR PDB

The use of paradichlorobenzene as a soil fumigant to control soil infesting insects has created a large interest in California.

The material in question is a white crystalline substance which is insoluble in water and evaporates slowly at a temperature of 55° to 75° Fahr. and more rapidly at higher temperatures. The vapor is more than five times heavier than air and more than twice as heavy as carbon disulfide vapor. It possesses a weak ether-like vapor which is practically nonpoisonous and noncombustible.

Paradichlorobenzene is such a long name that it seems advisable to abbreviate it by using PDB for short. Various trade names such as 'Paracide,' 'Crystal Glass,' etc., have already appeared, and many others will soon follow.

In applying the material two considerations are important: soil moisture and temperature. Because gases do not readily circulate in a thoroughly wet soil it is useless to apply paradichlorobenzene unless the soil is not more than ordinarily moist, as is usually the case in California during the summer and fall except just after irrigations. In such cases a week or two after the application of water would be preferable. The soil temperature should range from 75° to 85° Fahr. for the best results, for under such conditions the paradichlorobenzene volatilizes more rapidly and the insects are more active, requiring a greater air supply, and are consequently more readily killed by the vapor.

In California the period from the first of May until November may be roughly designated as the proper time to make the applications, provided the soil temperature is over 55° Fahr. and the soil moisture is not excessive.

From 3/4 to 1 ounce of paradichlorobenzene is sufficient to treat an average-size tree. First, level the surface of the soil around the base of the tree; then sprinkle the material around the tree in a continuous band or circle 2 inches wide with the inner margin 2-4 inches from the bark of the tree. Cover the material with soil around the base of the tree to a depth of 2-4 inches and pack well with several strokes of the shovel.

Under eastern conditions, where the use of this insecticide has been extensive, it has been applied chiefly to peach trees on peach root-stocks. The eastern investigators caution against using it on trees under six years of age, although younger trees are reported to have been treated with no injurious results in many instances.

In California apricot trees on Myrobalan rootstock and infested with the Pacific peach tree borer have been treated with good results in killing the borers without injury to the trees. Even nursery stock on Myrobalan and peach roots treated in the early summer showed no ill effects, but such work should receive more attention before general recommendations can be made.

California conditions are so different from those in the southern and eastern states that it is to be expected that we shall encounter many unusual problems in the handling of the material and that its uses may be very greatly enlarged.

Paradichlorobenzene is being recommended by some insecticide dealers for all woodboring insects, particularly for the western flatheaded borer. This insect and the other wood borers which work above ground cannot be satisfactorily reached by the fumes of the fumigant and cannot be controlled by it!

Although paradichlorobenzene has been extensively used over a period of eight years in California there is still much to be learned regarding it and a great deal of experimental work remains to be done. The action of the vapor on the roots of the plants is so slow that the after-effects may not be noticed for several years, and trees treated in the preliminary tests of 1921 are still under observation. While a single treatment may produce no ill effect we are not now able to determine what results may develop from successive treatments over a period of years. Therefore, the growers should take all precautionary measures possible and at least observe the following:

- 1. Avoid using excessive dosages.
- 2. Do not place the crystals in contact with the bark of the trunks, stems, or the roots of the plants.
- 3. Do not apply the material immediately before or after irrigation and do not wet the surface of the soil until two or three weeks after applications of the crystals, or until the crystals have volatized.
- 4. In treating nursery stock and young trees remove the residue after three weeks.
- 5. Do not apply paradichlorobenzene during the winter and early spring. Late summer and fall are the best times for such applications.
- 6. Only one application a year is advisable. Several treatments in one season may be fatal to the plants.

7. Paradichlorobenzene is recommended in the orchard and garden only for insects which attack the plants at or below the surface of the soil and cannot be used for borers which infest the trunks and limbs above the ground.

# PETROLEUM AND PETROLEUM DISTILLATES

Crude Petroleum.—The use of crude petroleum is almost entirely limited to the winter spraying of deciduous trees when the buds are entirely dormant. It is generally applied from November to February. The crude-oil emulsion is especially recommended for black scale (Saissettia oleae), European fruit Lecanium (Lecanium corni), European or Italian pear scale (Diaspis piricola), cherry scale (Lecanium cerasorum), and other scales infesting deciduous fruit trees. It is practically the only spray treatment which has been effective against European or Italian pear scale, and will destroy the winter eggs of many of the aphids, of the red spider, and of some of the defoliating caterpillars.

When crude oil is thoroughly applied it sometimes penetrates the fruit buds to a considerable extent, and may injure and even kill some of them. The great majority of the buds are not injured, however, but appear to be stimulated to a more vigorous growth, and to the production of foliage resistant to disease. It is good practice, especially in dry seasons, not to apply crude-oil emulsion until there is indication of swelling of the buds.

A natural crude petroleum, testing about 23° Baumé, is preferred, as it contains some of the lighter and more penetrating oils. Heavier crude oils have given satisfactory results, even those testing 18° and lower. Residuum oils (the residue of crude petroleum after the lighter portions have been distilled off) can be used if natural crude oil is unobtainable, provided their content of asphaltum is not too high to prevent their emulsification.

# Crude-Oil Emulsion. FORMULA 22

Water to make	gallons
Liquid soap	gallons
Natural crude petroleum (21°-24° Baumé)	gallons

Partly fill the spray tank with water, add the liquid soap, agitate thoroughly for 1 minute, add crude oil, and continue the agitation while running in the remainder of the water. If liquid soap cannot be obtained, use 20 pounds of fish-oil soap dissolved in 10 gallons of boiling water to which 3 pounds of caustic soda or lye have been

added. To kill moss or lichens on fruit trees, add 2 pounds of caustic soda or lye to the formula.

During the spraying operation this emulsion should be thoroughly agitated and great care taken to wet all of the twigs. From 8 to 10 gallons should be used on a tree.

If the amount of crude oil is reduced from 25 gallons to 15 gallons in this formula, crude-oil emulsion may be used on olive trees for the control of black scale.

Kerosene Emulsion.—Kerosene of about 40° Baumé, applied in the form of an emulsion, has been used to a considerable extent as an insecticide, particularly on citrus trees. The cheaper, unrefined distillates have now largely replaced kerosene as a foliage spray. These are more effective as insecticides, so that smaller percentages may be used in the emulsions, but coupled with their superior insecticidal properties is their greater toxicity to fruit and foliage. The toxicity varies with climatic conditions, foliage injury being most certain in dry weather with a temperature of 95° Fahr. or more. Unfortunately, the season when spraying is most effective against scale insects on citrus trees is often during the hottest and driest months. It seems impossible to guarantee immunity from damage under all conditions with any of the distillates obtainable.

Little injury to citrus fruit and foliage occurs in the coast regions where distillate emulsions have been used, but in the interior sections to use this insecticide is very hazardous.

Kerosene emulsion is the safest of the petroleum-distillate sprays, although the most expensive. The 'W. W.' or 'Water White' is a trade name of a low-grade kerosene which is safer than the usual grade of material sold as 'distillate.' The highly refined 'case goods' kerosene has been found to cause the least amount of injury of any of the petroleum derivatives, but its cost is prohibitive except on a small scale. If much of the kerosene emulsion is allowed to run down the trunks of young trees, injury is likely to occur just beneath the surface of the ground.

The following formula is intended for use on citrus trees:

	Fori	MULA 23		
	Lar	ge quantity	Small quantity	
Kerosene	15	gallons	1 gallon	
Liquid soap	3/4	gallon,	soap powder	$\frac{1}{4}$ pound
(Or hard soap	4	to 12 pounds	)	
Water to make	.200	gallons	$\frac{1}{2}$ gallon	
			(dilute 1 :	to 9)

If liquid soap is available, it is preferable to hard soap, since it requires no heating. Hard soap, preferably fish-oil soap, is cut in thin slices and dissolved in hot water. The soap is placed directly in the spray tank with 10 or 15 gallons of water or more (the exact amount is not important) and the engine then started. The oil is now added slowly, and the materials are emulsified by being run through the pump under pressure. After a few minutes the rest of the water may be added, and the spray is ready to be applied.

'Tree' Distillate Emulsion.—Certain 'tree' distillates, testing 31° to 32° Baumé, said to be selected and partially refined, have lately displaced to a considerable extent the heavier distillates of 27° to 28° for use on citrus trees.

# FORMULA 24

Tree distillate (31°-32° Baumé)	4	gallons
Liquid soap	3/4	gallon
(Or hard soap	4	to 12 pounds)
	200	gallons

These materials are emulsified in the manner explained for the kerosene emulsion, formula 23.

# Lubricating-Oil Emulsion.

#### FORMULA 25

Lubricating oil4	to 6	gallons
Calcium caseinate	$\frac{1}{2}$	pound
Water to make	100	gallons

Mix calcium caseinate in small quantity of water, add the oil, stir and agitate thoroughly in tank with remainder of water.

Heavy Distillate Emulsions.—For use on olives, the following mechanical emulsion is recommended:

# FORMULA 26

Distillate (28° Baumé)	7	gallons
Caustic soda (95 per cent)5	to 7	pounds
Water to make	200	gallons

First dissolve the caustic soda in a small amount of water and add to the water in the spray tank; begin the agitation and slowly add the distillate, continuing the agitation during application. This spray will also remove lichen or moss from trees.

For use on dormant deciduous trees the following is recommended:

# FORMULA 27

Distillate (27°–28° Baumé)	20	gallons
Fish-oil soap	30	pounds
Water	12	gallons

Dissolve the fish-oil soap in the water, heating it to the boiling point; add the distillate, and agitate thoroughly while the solution is hot. For use, add 20 gallons of water to each gallon of the above mixture.

Commercial Prepared Emulsions and Miscible Oils. — Many growers realize the difficulty of securing proper materials for homemade emulsions and the variability of the home-made mixtures even under the best conditions. They prefer to buy manufactured products, especially when only small quantities are needed; the commercial emulsions and miscible oils are no more effective than a good homemake preparation but are more convenient. These preparations are on the market in great variety, many being sold under trade names. Practically all grades of petroleum distillates, as well as crude petroleum, are obtainable in a form ready to be used, after simple dilution with water. If these ready-made preparations are to be used, it is especially important to purchase only from reliable and well-known manufacturers or dealers. The commercial products in general are satisfactory for use for the purposes indicated for the above formulas.

Distillate Emulsion and Tobacco Extract.—This is recommended for the control of thrips. The government formula is as follows:

# FORMULA 28

Distillate emulsion	10	gallons
Black Leaf 40 (Nicotine sulfate 40 per cent)	1	pint
Water to make	200	gallons

When this formula was first prepared there were few commercial oil sprays on the market, so that it was necessary first to make a distillate emulsion (formula 27).

In recent years there have appeared the miscible oils, which may be used as follows:

#### FORMULA 29

Miscible oil	5	gallons
Black Leaf 40 (Nicotine sulfate 40 per cent)	1	pint
Water to make	00	gallons

These formulas are for use against the adult 'black thrips,' and should be applied liberally as soon as any considerable number of insects are found upon the trees. Do not fail to make daily inspections after the buds begin to swell. Applications should be repeated if necessary until the adults begin to lessen in numbers.

In case the 'white thrips' appear in destructive numbers later, the same formula may be safely used if the oil content is decreased and the nicotine increased as follows:

Formula 30	
Distillate emulsion	gallons
Black Leaf 40 (Nicotine sulfate 40 per cent)	pints
Water to make 200	gallons
Formula 31	
Miscible oil	gallons
Black Leaf 40 (Nicotine sulfate 40 per cent)	pints
	gallons

For work with thrips, the greater force and volume delivery of the spray gun has rendered it superior to the spray rod, insuring not only a better but a quicker and easier job. The loss in material is more than overcome by the rapidity and ease of operation.

# RESIN WASH

The resin wash is chiefly used for young and tender nursery stock, because it does not cause the injury often following the application of petroleum distillates. The preparation is:

# 

To a gallon of hot water in an iron kettle add the fish oil and the resin, and heat until the latter is softened. After first dissolving the caustic soda in a small quantity of water add it and stir the mixture thoroughly. After this pour in enough water to make 50 gallons of spray material.

# SOIL DISINFECTION

For the prevention of damping-off and of many specific soil-borne infections, treatment may be practical in cases such as seedbeds, greenhouse soil or where limited amounts of material are to be dealt with. Plants at first are slightly retarded, but soon grow with increased vigor in properly disinfected soils.

Steam Cooking.—This is generally considered the most effective method of soil treatment for the above purposes and various devices have been employed for doing the work. A system of 1½-inch pipes may be laid 18 inches apart and 1 foot below the surface. These pipes should be perforated on their lower sides with ¼-inch holes at intervals of 6 inches and should be supplied with steam at a pressure of 80 to 150 pounds. The soil should be covered with blankets before the steam is admitted, and potatoes buried in different places in the soil. After treatment for an hour, the potatoes may be examined; if they are cooked, the treatment may be considered effective. The soil may be used in place or may be removed to clean benches or beds, using care not to contaminate it again. Benches, frames, etc., should be drenched with boiling water or formaldehyde solution before use. See below.

The inverted-pan method consists in admitting steam below an inverted galvanized iron pan, furnished with handles for moving, which is pressed down to confine the steam. A size 6 by 8 feet 6 inches deep has been recommended.

Injurious insects, fungi, nematodes, and weed seed are destroyed by steam cooking and it has been reported in some cases that the cost has not been greater than that of weeding untreated soil.

Surface Firing.—Brush is frequently piled on seedbeds prepared for sowing and burned. Seed is sown as soon as possible with a minimum stirring of the surface. The effect in this case is very superficial.

Formaldehyde Treatment.—Formaldehyde may be used on seedbeds prepared to sow. The soil may be soaked with a solution of 1 pound of formalin in 6 gallons of water. The soil should be kept covered for a day and allowed to stand for a week before sowing.

Hot Water Treatment.—Considerable benefit may be derived from drenching the soil with boiling water. Empty pots, flats, pots with soil, and implements may be immersed in boiling water for 5 minutes.

# SPREADERS

Spreaders are often added to sprays to give them a more even distribution over the surface of the leaves and to prevent them from collecting into drops. Some of them also have insecticidal value and others act as adhesives. So much is claimed for these materials which is not fully warranted that many persons have come to feel that none should be recommended. However, the advantages gained should not be entirely overlooked, and we include here some of the more important substances used for these purposes.

Casein.—This is a comparatively new material for use as a spreader and adhesive in sprays. It is a dry product which readily mixes in cold water and is put up in small or large containers. One and one-half pounds are sufficient for 200 gallons of the diluted spray. Casein is soluble only in alkaline solutions and is therefore worthless in acid insecticides and fungicides, which are, however, seldom used.

Flour Paste, Billboard Paste.—These materials are excellent spreaders and act as adhesives as well. They may be used with safety in all sprays, because they give no chemical reactions. Flour paste and certain of the dry billboard and paperhanger's pastes should be mixed in a small quantity of hot water before adding to the spray tank. They are somewhat difficult to handle. A specially prepared billboard and paperhanger's paste, known as 'steamed paste,' is already cooked, and as a wet paste mixes readily with cold water. It may be obtained in barrel lots or in small quantities from paint and paper dealers. The amounts to be used are as follows:

Flour (cheap grade), 2 to 4 pounds to 200 gallons of dilute spray material.

Dry billboard paste, 2 pounds to 200 gallons of dilute spray material.

Steamed paste, 4 pounds to 200 gallons of dilute spray material.

**Glue.**—As a spreader and adhesive, glue has long been used in sprays, and, like the flour pastes, may be used in all kinds of materials. Two ounces of dry glue dissolved in hot water are sufficient for 200 gallons of diluted sprays.

Oil Emulsions and Miscible Oils.—Because of their penetration, these materials are often of value in carrying other materials, like nicotine. They should be used sparingly, about 2 gallons to 200 gallons of diluted spraying materials. When so diluted they have little value except as spreaders.

Resin and Fish-Oil Soap.—This is often used with bordeaux mixture (see formula 15). It is somewhat tedious to prepare and may now be purchased ready for use. This is very similar in character to the resin wash (see formula 32).

**Soap.**—This is one of the oldest and best known spreaders and is often used in spray for this purpose as well as for an emulsifier and insecticide. As a spreader for such materials as arsenate of lead, for codling moth, use 4 to 12 pounds of fish oil soap to 200 gallons of diluted spray material.

#### STRYCHNINE

Poisoned Barley or Strychnine-coated Barley.—Following is the latest government formula for preparing poisoned barley for California ground squirrels.

Formula 33		
Barley (clean grain)	16	quarts
Strychnine (powdered alkaloid)	1	ounce
Bicarbonate of soda (baking soda)	1	ounce
Thin starch paste	3/4	pint
Heavy corn syrup	1/4	pint
Glycerin	1	table spoonful
Saccharine	1/10	ounce

Make a thin starch paste by dissolving 1 heaping tablespoonful of dry gloss starch in a little cold water, which is then added to ¾ pint of boiling water; boil and stir constantly until a clear, thin paste is formed. Mix thoroughly 1 ounce of powdered strychnine (alkaloid) and 1 ounce of common baking soda. Sift this into the hot starch paste and stir to a smooth, creamy mass. Add ¼ pint of heavy corn syrup and 1 tablespoonful of glycerin and stir thoroughly. Add ¾ ounce of saccharine and stir thoroughly. Pour this mixture over 16 quarts of clean barley and mix well so that each grain is coated. Then spread the grain out to dry before being sacked.

Caution.—All containers of poison and all utensils used in the preparation of poisons should be kept PLAINLY LABELED and OUT OF REACH of children, irresponsible persons, and live stock.

# Poisoned Vegetables for Gophers.

# Formula 34

Sweet potatoes, parsnips, or carrots (cut in 3/4-inch cubes)	4 quarts
Flour paste	$\frac{1}{4}$ pint
Strychnine alkaloid, powdered	½ ounce
Saccharine	$\frac{1}{32}$ ounce

Put strychnine and saccharine into flour paste as directed for ground-squirrel poison. When mixed pour over baits and stir until well coated.

# SULFUR AND SULFUR COMPOUNDS

Dry Sulfur.—For dusting upon plants for the control of surface mildew, red spider, or other parasites, the fineness of the sulfur is an all-important consideration. Flowers of sulfur, the finest and fluffiest grade of sublimed sulfur, has been heretofore recommended for application as a dust, but at present there are upon the market several brands of extremely finely ground sulfurs, which are as fine as some of the best grades of sublimed sulfur and no more expensive. Some of these sulfurs, which have been specially prepared for dusting, are ground to pass a 200-mesh bolting cloth. If 9 parts of sulfur are thoroughly mixed with 1 part of hydrated lime, kaolin, or other inert powder, caking may be avoided.

Sulfur Pastes or Wettable Sulfurs.—For various reasons it is often desirable to mix sulfur and water and apply it to plants as a spray. Sulfur, however, is not easily wetted with water and it is a difficult matter to make a uniform mixture of the two. It has been found that a number of substances—soap, calcium caseinate, oleic acid, glue, diatomaceous earth, flour, dextrin, etc.—when mixed with water and sulfur have the property of counteracting the mutual repulsion of sulfur and water without otherwise altering the nature of the sulfur. Certain of these substances have been used in the preparation of commercial sulfur pastes or wettable sulfurs. These commercial pastes, as now manufactured, contain from 45 to 50 per cent or more of sulfur in a very finely divided condition, the remainder being water and one of the substances mentioned above. The effect of these pastes is that of dry sulfur. The usual strength to use is:

#### FORMULA 35

Commercial sulfur paste	10	pounds
Water	100	gallons

Home-made Wettable Sulfur.—The usual grades of sublimed or powdered sulfur may be wetted in the manner described in formulas 36 and 37, but for the best results the finest grade of sulfur obtainable should be used. The sulfurs especially prepared for dusting are recommended for this purpose.

A satisfactory wettable sulfur can be easily made at home by the use of glue water as follows:

FORMULA 30	
Powdered glue	$\frac{3}{4}$ ounce
Hot mater	11/ 11

Hot water  $1\frac{1}{2}$  gallons Sulfur (flowers or powdered) 5 pounds

Dissolve the glue in hot water or soak over night in 1½ gallons of cold water. Add the glue water to the sulfur a little at a time and work up into a smooth paste as free from lumps as possible. Rubbing is better than stirring. Wash this paste into the spray tank through a fine screen, using the remainder of the glue water to wash it through and a stiff brush to break up the remainder of the lumps. Then add plain water to make 100 gallons.

Another very good and cheap formula is:

Make a paste of: Formula 37

Calcium caseinate	· · · · · ·	pound gallon
Mix this with: Sulfur (sublimed or powdered)		pounds
Then add: Water to make	100	gallons

Self-boiled Lime-Sulfur Wash.—A preparation of sulfur largely used in the eastern states for a summer spray on peach and other tender foliage and comparable in use to the wettable sulfur preparations.

#### FORMULA 38

Quicklime	32	pounds
Sulfur	32	pounds
Water to make	200	gallons

Put the quicklime in a suitable container and add water to start slaking, about 12 gallons (hot water for sluggish lime and cold for active). Work the sulfur through a sieve and add to the lime, stirring

to prevent caking. Add enough water to make a paste. When the violent boiling ceases, add cold water to make up to the final amount. If allowed to stand hot, the mixture becomes caustic. The wash must be strained and applied with a pump having a good agitator. This is not a solution but a finely divided form of sulfur comparable with the product of formulas 35, 36, and 37.

Lime-Sulfur Solution.—This is the most active form in which sulfur compounds are commonly used in the control of insects or fungi. Its causticity prohibits its use on any foliage except that of the more hardy plants, and then in a very dilute form. Its principal use is as a dormant spray for the control of certain fungus diseases, scale insects, red spider, and a variety of other pests of deciduous trees.

The horticulturists of the state are being supplied with concentrated commercial lime-sulfur solution of good quality and at reasonable prices. The great bulk of this important pest remedy used in the state is therefore of commercial manufacture, testing 32° Baumé. It is only necessary to dilute this with water before spraying. The usual dilution for dormant spray is 1 gallon of the concentrated solution with water added to make 10 gallons of spray material (1–10). Where the commercial product is not of a concentration of 32° Baumé, add more or less water according to the strength of the concentrated product. This should be determined at the time of purchasing.

Lime-sulfur solution may be made at home as follows:

#### FORMULA 39

Stone lime	50	pounds
Sulfur (sublimed or powdered)	100	pounds
Water to make	50	gallons

Heat about one-third of the total volume of water required. When the water is hot add all of the lime, and then immediately all the sulfur, which should previously have been made into a thick paste with water. After the lime is slaked another third of the water should be added, preferably hot, and the cooking should be continued until a clear orange-colored solution is obtained (usually 45 to 60 minutes), when the remainder of the water should be added, either hot or cold, as is most convenient. The boiling due to the slaking of the lime thoroughly mixes the ingredients at the start, but subsequent stirring is necessary if the wash is cooked by direct heat in a kettle. After the wash has been prepared it must be allowed to settle and then strained through a fine sieve as it is being run into the spray tank. The resultant product is a concentrated solution of lime-sulfur, which

should be diluted about six times with water for a winter spray. By means of a suitable hydrometer, a simple table and an easy computation, the solution may be made to any desired concentration. This is particularly important where the material is to be used on plants in foliage which may be easily injured if the spray is too concentrated.

Lime-sulfur is now obtainable in the form of a dry powder which is used by dissolving in water. Forty pounds to 200 gallons of spray is usually recommended for application on dormant trees. A strength of about 10 pounds to 200 gallons is generally recommended for use on foliage as in treating apple scab, red spiders, etc.

The recommendations for the dry lime-sulfur sprays call for the use of a smaller amount of total sulfur in general than is used with the liquid lime-sulfur solution, but the comparative efficiency of the preparations seems not to be fully determined.

Lime-Sulfur Dip. FORMULA 40	
Lime (unslaked)	8 pounds
(or 11 pounds of commercial hydrated lime)	)
Flowers of sulfur	24 pounds
Water	100 gallons

Slake the lime, sift in the sulfur, and make a thin paste; add water to make 30 gallons, and boil for one hour, stirring during the process. Add water while cooking to maintain the original amount of 30 gallons. Strain or siphon off the liquid and make up to 100 gallons. An excess of lime or sediment in the dip will injure the sheep and wool.

The standard lime-sulfur dip as made above may be combined with an equal quantity of standard arsenical dip (see formula 4) for sheep "ticks."

Alkali Sulfides.—Sulfides of soda ('soluble sulfur') are sometimes used in place of lime-sulfur solution and have some advantages over the liquid preparations.

# **TOBACCO PREPARATIONS**—See also "Nicotine Dust and Combinations," p. 118

Concentrated commercial preparations of tobacco have almost entirely superseded the home-made tobacco infusions on account of their greater convenience and uniformity. A material containing 40 per cent nicotine in the form of nicotine sulfate (Black Leaf 40) is recommended for the preparation of contact insecticides containing nicotine. The usual formula is:

# FORMULA 41

Tobacco extract (Black Leaf 40)	
Fish or whale-oil soap4 to 5	pounds
Water 100 to	150 gallons

For small quantities, use 1 teaspoonful to 1 gallon of water.

# FORMULA 42

Black Leaf 40	1	pint
Dry billboard paste	2	pounds
Lye	8	ounces
Water	150	${\bf gallons}$

Make a paste of the dry material and add it to the water and nicotine. This spray is intended for plants like potatoes, tomatoes, etc., which are sensitive to soap mixtures.

**Tobacco Dust.**—Finely ground tobacco dust finds some use as an insecticide, particulary in the control of aphids. Fifty per cent of kaolin or hydrated lime is sometimes mixed with it as a diluent.

# WEED KILLERS, TREE KILLERS

Carbon Disulfide.—For killing morning glory, apply in dry soil in holes 18 inches deep and 3 feet apart each way. Put 4 ounces of the liquid in each hole and cover. This does not permanently injure the soil.

Commercial Weed Killers.—During the past few years a number of very effective weed killers have been prepared by commercial manufacturers, which when applied according to recommendations, give very satisfactory results. These may be purchased from insecticide dealers, florists, and nurserymen.

**Salt.**—Common salt may be applied on walks or similar places where it is desired to prevent the growth of all vegetation. In the studies of barberry eradication it was found that 10 pounds of common salt poured about the base of the large shrubs was one of the surest means of eradication. Soil with which the salt comes in contact is injured for growing plants.

Sodium Arsenite.—See p. 110. This is one of the most widely used of weed killers. Sprayed on foliage or the soil it is very destructive to vegetation. Like common salt, it permanently injures soil where

applied in considerable quantity. One pound of the arsenite in 10 to 25 gallons of water may be sprayed on soil or foliage. For killing trees, use 1 pound to 2 gallons of water, girdle the tree by downward strokes of the axe and pour 1 pint to 1 quart of the solution into the cuts. This is a dangerous poison to handle, to get on fodder, or to inhale when preparing it.

See also under "Lawns," p. 45.

# WHITEWASH

The ordinary formula is as follows:

# Formula 43

Water	2 gallons
Quicklime	10 pounds

Add more water after slaking to bring the wash to the desired consistency.

A more durable whitewash for tree trunks, barns, and fences is as follows:

# FORMULA 44

Quicklime	5	pounds
Salt	1/2	pound
Sulfur	1/4	pound

Slake the lime slowly with about 5 pints water and add the salt and sulfur while it is boiling. Add enough water to make a good wash. This is good for whitewashing the bodies of trees in the fall. In localities where there are deer this whitewash is not recommended, as the deer are said to be attracted by the salt it contains and injure the trees.

# FORMULA 45

# GOVERNMENT WHITEWASH

Quicklime	40	pounds
Salt	15	pounds.
Rice flour	3	pounds
Spanish Whiting	$\frac{1}{2}$	pound
Glue	1	pound
Water	. 5	gallons

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